Referee #2

Specifically, the authors show significant back-azimuthal variations of splitting parameters but there is little effort to explain these observations by possible layered anisotropic structures. Much effort is put into deliminating different anisotropic domains and regional variability, but there is not much discussion on the relation between observed fast-axes and specific tectonic processes which may explain the observations. Possible effects of mantle flow in the asthenosphere and anisotropic effects of the crust are also not considered.

To model shear-wave splitting variations with back-azimuth, the parameters are usually plot at modulo-90, which improves, though only artificially, the coverage. Moreover, doing that one implements an assumption of horizontal symmetry axes. We often observe and show that splitting parameters of waves from opposite back-azimuths, i.e., from φ° and φ+180°, differ. We have prepared a figure (see Fig. 2 in reply to referee #1) with synthetic splitting for a model with tilting axis exhibiting clear 360° periodicity and due to a presence of noise offering a tendency of 90° periodicity (EGU 2011-3164, Geophysical Research Abstracts 13, 2014), which can be misinterpreted as a double-layer model.

As we explain below and show (Sileny and Plomerova, PEPI 1996) in case of a generally oriented anisotropy in 3D we have to invert for symmetry axis orientation and cannot associate the (average) fast S polarization directly with this axis. However, any inversion requires good azimuth-incidence angle coverage, which we do not have for SKS waves (see Fig. 1 in a reply to referee #1). To overcome this obstacle one can perform a joint inversion with independent data sets, e.g., P- residuals (e.g., Vecsey et al., Tectonophysics 2007) to improve the coverage. We incorporate possible effects of asthenospheric mantle flow and crustal effects into the discussion:

In comparison with fast moving plates European plate moves very slowly and without a clear direction (e.g., Gripp and Gordon, 2002), which decreases effects coming from the asthenosphere. Relatively smooth relief of the lithosphere-asthenopshere boundary north of the BM (EGU2012-8782, Geophysical Research Abstracts 14, 2012) does not suppose any distinct small-size circulation in the sub-lithospheric mantle to substantially contribute to the observed variations of the shear-wave splitting.

I do not agree with the authors' implication (p. 239) that Fresnel zones cannot be used estimate the depth of anisotropic domains from variable results at neighboring stations.

We modify appropriately lines on page 239 to be more specific what we mean.
Simple estimate of a depth interval where the source of anisotropy could be located considering Fresnel zones of rays approaching two nearby stations (e.g., Alsina and Snieder, 1995; Chevrot et al., 2004) can be used only in case of azimuthal anisotropy, i.e., when mantle fabric can be approximated by anisotropic models with horizontal symmetry axes. However, this is not generally valid for complex fabrics of the continental mantle lithosphere (e.g., Babuška and Plomerová, 2006). Particularly it concerns the upper limit of estimated depth interval (minimum depth) to which the source of anisotropy can be located. Considering anisotropy with inclined symmetry axis and evaluating the splitting parameters in the QT plane, we get different splitting parameters for waves approaching the station steeply, but from opposite azimuth. Resulting splitting (fast S polarization and δt) depends on direction of propagation, while considering the azimuthal anisotropy (i.e., as a 2D

phenomenon), the fast S polarization is “constant” and the fast S azimuth is used to be associated with orientation of the symmetry exes. In case of dipping symmetry axes, we cannot have any information about the minimum depth, below which a source of anisotropy could be (e.g., depth z1 in Alsina and Snyder, 1995) and we cannot associate the fast S polarization azimuth (for a particular back azimuth) directly with the symmetry axis, but we have to invert for that.

Generally, in the discussion, it is not always clear which statements are really supported by the data and the results given in this paper. For example, from the results and from the discussion it is not clear how the authors obtain information on the dip direction and how relevant this is.

On pages 239 and 240 we explain and give references to our previous studies which include also P-wave anisotropy study and joint inversion of P and S-wave anisotropic parameters in southern part of the PASSEQ array.

Readability may be improved by shortening the discussion and by better highlighting the original contributions made here.

We highlight the original contributions, split the discussion into three parts, add subtitles and include implications for the assembly of individual tectonic units and their development.

Furthermore, at the beginning of the discussion section, the authors explain the “two types of variations need to be followed”: : : “(1) changes of polarization parameters “: : : “(2) changes of apparent parameters “.. “The former leads to 3D modeling of the mantle domain fabrics”: : :

What is the difference between “polarization parameters” and “apparent parameters”? It is not clear which data sets the authors have in mind. Do they refer to P-wave polarization and SKS shear wave splitting parameters? Or does this relate to SKS polarization and a parent splitting parameters? Please be more specific. I also did not find any further reference to the 3D modeling mentioned above.

We have in mind the SKS splitting parameters and reformulate the section.

We change the confusing formulation and stress a necessity ….” to follow changes of apparent polarization parameters, i.e. fast S polarization and δt, (1) at individual stations of the array in dependence on direction of wave propagation as well as (2) regional variations for particular directions of propagation. The former leads to 3D modelling of a structure of individual mantle domains, the second to delimiting the domains. Reliable modeling of anisotropic structures in 3D requires a good directional coverage, which is not the case of only the SKS waves, but regionalization of the mantle is plausible.”

Further on the authors state (p. 242): “Anisotropic signal can be detected if the SKS propagates through an anisotropic block of a sufficient thickness, i.e., at least of one wavelength thick (Plomerová et al., 2011).“

This statement is not correct, as a thin but highly-anisotropic layer may also cause significant shear wave splitting**. For example**, a hypothetical 30 km thick, highly-anisotropic crustal layer may result in a delay time of 0.5 sec, the wavelength is not relevant here! The wavelength may matter in heterogeneous media, where effective anisotropy due to layering (of isotropic material) plays a role.

We modify the text: “SKS waves detect anisotropic signal if they propagate through an anisotropic block of thickness which is comparable with the wavelength (Plomerová et al., 2011).“

The example given above by the referee, i.e., “a thin highly-anisotropic layer represented by a hypothetical 30km thick crust resulting in 0.5 s delay” is close to the ~one wavelength approximation for waves with SKS having dominant periods of ~6-8s. However, due to heterogeneous structure of the crust in central Europe, an existence of such hypothetical layer is not probable. Moreover, SKS waves do not split in transversally isotropic media with vertical symmetry axes (e.g., sedimentary layers).

At several instances the authors mention the number of pairs of splitting parameters (1009). However, for how many stations did they obtain splitting parameters? What is the average number of splitting measurements per station?

Submitted manuscript contains an electronic supplement with Table S1 showing all splitting parameters, their quality, etc., which we considered as sufficient. We complement the ms. with information on “statistics” of splitting measurements as requested:

Splitting parameters – the fast S polarizations and split delay times – were determined at 158 stations of the PASSEQ array, with 6.4 splitting pairs per station, on average. Splitting evaluations from all 15 events were feasible at 19 stations of the array.

I also have a number of minor suggestions that may help to improve the readability of the manuscript:

We agree with the suggestions helping to improve readability of the manuscript and incorporate them into the text.