Review

of

Behnen, et al, Investigation of Seismic Anisotropy in the Undisturbed Rotondo Granite

submitted to EGUsphere, 2024

This is an interesting paper, which can be useful to advancing understanding, after the authors' responses to the following suggestions for MAJOR and minor revisions.

Line 46. This statement is probably not true, and in any case should be supported with references. A better statement would be, "A commonly studied type of seismic anisotropy..."

Line 55. It should be specified here that $C_{ij}$ is measured in the principal coordinate system of the medium, not the survey coordinate system.

Line 57. These phase velocities are correct, but the data measure group (ray) arrival times, hence group (ray) velocities, at ray angles, not phase angles. The authors should discuss these issues, referring *e.g.* to Thomsen (1986).

Line 70. The reference here should not be "near-vertical", but rather "close to the symmetry axis", which differs from the vertical in TTI media.

Line 102. It appears from Fig. 1 that the boreholes all lie in or close to the vertical plane beneath the tunnel. It would be useful to rotate the inset in Fig. 1 to align with that plane, thus showing the deviations (if any) from the plane. If the data are all co-planar, that reduces their ability to describe tilted orthorhombic symmetry.

Line 124. This claim needs a reference.

Line 127. This "explanation" is misleading. A better explanation would be, "This can be explained by P-S conversion at the borehole wall near to the source.."

LINE 134. This 3C orientation issue results in a MAJOR limitation in the analysis. The geophones may be oriented from the data itself, assuming vector fidelity (c.f. Gaiser, 2007, Geophysics, 72(3), p. V67–V77). For each geophone-source pair:
a) Rotate (3D) the 3C data such that the energy in the P-wave window is maximized on the new $x_3$ axis, which is now aligned with the incoming P-wave polarization, which is close to the P-wave propagation vector. (If this is not pointing back at the source, then either the medium is not uniform (as assumed), or the data are not vector-faithful (as assumed).)
b) Rotate about the new $x_3$ axis such that the cross-correlation of the $x_1$ and $x_2$ traces is maximized, with a cross-correlation lag. The geophone is now aligned (3D) in the principal coordinate system, with the three modes separated onto the three axes.
c) If you assume (as you apparently do below), that S1 is the SH mode, then this specifies the new $x_1$ axis as lying in the TTI plane of symmetry, which by assumption is the same for all geophones, and is determined absolutely from the P-wave velocities as you describe.
d) These rotations, run backwards, determine the original orientation of the geophone.
e) The same operation, with the same geophone but different source, should yield the same geophone orientation and the same orientation of the principal coordinate system; if not you

can minimize the misfit, or use the differences to refine the assumptions.
f) With the 3C data now fully specified, your analysis is more robust, including analysis of shear-wave polarizations.

LINE 203, Table 3. This table shows the result that $\varepsilon<\delta$, which results in unusual SV-wave propagation (cf. Tsvankin and Thomsen, 1994, Geophysics, 59(8), 1290-1340). If this result survives the more robust 3C analysis described above, the authors should comment.

Line 226. Here the authors assume that S1=SH. This should be discussed.

Line 265. This is a strange result. Authors should show how the measured $V_{S2}$ compare with $V_{SV}$ for their preferred model, as a function of angle.

Line 324. The logging data undersample near-vertical fractures.

Line 228-331. These borehole methods estimate the stress in the immediate vicinity of the borehole, whereas the overburden load varies along the raypaths. Authors should discuss the issue of stress heterogeneity.

Line 456. Authors: provide the name of the university for this Ph. D. thesis.