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Interactive comment on "Numerical Modeling of Fluid Effects on Seismic Properties of Fractured Magmatic Geothermal Reservoirs" *by* Melchior Grab et al.

Anonymous Referee #2

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Review of Grab et al: "Numerical modeling of fluid effects on seismic properties of fractured magmatic geothermal reservoirs " Submitted to Solid Earth Discussions

This paper concerns the influence of fluid-bearing fractures in magmatic and volcanic rocks, for the purpose of using seismic properties to characterize geothermal reservoirs. In particular it deals with the dispersion of seismic velocities (expressed through the P wave modulus and shear modulus) and the attenuation of the P and S waves (1/Qp and 1/Qs), using poroelastic numerical modelling based on Biot's theory. This approach is still fairly uncommon in standard rock physics applications, but has certainly become more common in the past 5 to 10 years, and is very powerful. In a fractured reservoir the seismic response is severely affected by the fluid flow, which

impacts the velocities and attenuation as a function of frequency in particular. Four different igneous rock types are tested, with a fairly large range in values of isotropic elastic constants, density, and porosity (and permeability). Fractures are incorporated into the 2D model, based on a geological study by Gudmundsson et al. (2002).

The paper is valuable and interesting; it is very well written, and easy to follow. I therefore recommend its publication with minor revisions. The abstract is clear and descriptive of the paper. The figures are generally well prepared and easy to follow (legend in Fig. 7c, d could be improved through). The language can be improved in some places (for example when using words like "what" and "why" after commas in sentences, where the word "which" should be used).

I have three general, but fairly minor, comments that the authors may want to address in the discussion of the paper: 1. The authors have a collected a large set of laboratory data, which is very good. However, it is not so clear to which confining pressures the laboratory experiments were made, and how the elastic moduli at zero confining pressure as well as the first and second velocity pressure derivatives were obtained. Most lab experiments have probably been carried out to confining pressures where the micro-cracks are not completely closed during pressurization (many 100's of MPa or even >1 GPa), which would make it difficult to obtain completely crack-free zero pressure elastic moduli. However, this is a secondary point when considering the effect of fluids in fractures on the seismic properties.

2. I think it is somewhat difficult to say how applicable these results are to an actual seismic data set and specific geological case. Since the igneous rocks can be rather heterogeneous. Therefore I view the contribution of Grab et al. as an exploratory study that demonstrates the importance of fluid effects on the seismic properties in a fractured rock, in a general sense. It would be nice for the future if the technique can be tested in situ, maybe in a borehole study

3. Although the results in the study builds in part on laboratory data, there are a lot of

numerical relationships and assumptions established and used in the paper, from the effective medium theory and the poroelastic theory. It is therefore difficult to appreciate how good the final model is in terms of testing it against real experiments or a laboratory case.

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