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Solid Earth Discussions

Interactive comment on "Effect of chemical composition on the electrical conductivity of gneiss at high temperatures and pressures" *by* Lidong Dai et al.

Anonymous Referee #2

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In their submitted manuscript the authors investigate the electrical properties of different gneiss samples at elevated temperatures and high hydrostatic pressures by means of state of the art experimental facilities. The paper focuses on the effect of the chemical composition to the measured conductivity and different conduction mechanisms are reported. Geophysical implication is also discussed. The work is interesting and worth publishing but additional aspects could also be revealed after further analysis of the experimental data. The authors should pay much effort to improve the quality of their work, in order to be suitable for publication. The following issues should be carefully addressed: 1. In my opinion, the author should not just limited to the calculations of the dc-conductivity but also explore the advantages of the complex impedance spec-

troscopy. Otherwise, they could measure the dc-conductivity by varying linearly the temperature at different selected pressures. I suggest using also other formalisms of impedance data, such as ac-conductivity and complex impedance presentation of their data. 2. According to my previous comment, it would be also desirable to present the results of all the measured samples (or at least of 2 of them) in suitable figures, i.e. real and imaginary parts of ac-conductivity and impedance as a function of the measured frequency at different T and P, except of the Cole-Cole plots of complex impedance. 3. In the measured frequency range (0.1 Hz-1 MHz) the overall conductivity should usually include contributions from grains interior, grain boundaries and electrodes polarization. In their fitting procedure the authors included only two types of contributions, with the main one the bulk conductivity. It has to be clarified if this refers to both grains interior and grain boundaries or only to the conductivity of the grains interior. In the former case, the 2 contributions should be separated. 4. An important finding which should be emphasized because it is rarely observed in minerals and rocks is the negative activation volumes that are observed, i.e. increase of conductivity with pressure. Their values should be calculated and compared with the activation volumes of the constituent minerals (biotite, feldspar and quartz) and/or other possible reported values of gneiss. Possible reasons for this finding should be also discussed. In fact, it is the effective activation volume that is found to have negative values and could be related to the influence of percolation effects in the grain boundaries. 5. Lines 208-211, "... the gneiss samples were unstable in the first heating cycle." This could arise from the existence of bound water that is trapped in grain boundaries or in the rock structure in the form of hydroxyls and is desorbed at high temperatures. In this sense, the conduction mechanism of low activation energies at the low temperature region could be related to proton conduction. The corresponding ac-conductivity spectra might give insights to these issues. This alternative explanation should be checked. Furthermore, the manuscript should be carefully revised to improve the quality of the English language. Some less important issues that have to be addressed: 6. Line 73: for the sake of completeness it would be desirable to briefly refer to these different types of

gneisses. 7. Lines 96, 102, 106, 493: the measured specimens are 3, not 4, as stated incorrectly. 8. Lines 155-156: It would better to use the symbol CPE for the constant phase element, instead of Cs which corresponds to a capacitor. 9. Table 3: I suppose that the last column corresponds to the correlation coefficients of the fitting procedure. Please change the symbol (greek gamma) to the correct one, R. In addition, taking into account the constructive comments of the 1st referee, I would suggest that the paper could focus not only to the effect of the chemical composition to the measured conductivity but also to the negative values of activation volumes, the geophysical implication that already exists in the manuscript and to the detailed investigation of the complex impedance spectra. In this sense, the title could be more general without focusing to the influence of chemical composition on the measured conductivity. For example “Complex impedance spectroscopy of gneiss samples at high temperatures and pressures”.

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