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

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Interactive comment on "Effect of chemical composition on the electrical conductivity of gneiss at high temperatures and pressures" by Lidong Dai et al. Response to the editor of Professor Ulrike Werban: The fact that the electrical conductivity increases with increasing pressure most likely indicates that the charge carrier is electronic, not ionic; the authors should investigate this point, which may help them to identify the phase that is conducting in the rock. In the present work, three different gneiss samples were selected to explore the effect of chemical composition on the electrical conductivity under conditions of 623âĂŠ1073 K and 0.5âĂŠ2.0 GPa. The chemical composition of sample

was efficiently controlled by the weight percentage of total content for Na2O + K2O + CaO = 7.12%, 7.27% and 7.64%. According to our obtained results, we found that the electrical conductivities of gneiss samples increased with the rise of the total content of alkali- and calcium ions. Furthermore, we designed the initial experimental procedure in order to explore the relationship of hydrous mineral of biotite content influence on the electrical conductivity of gneiss at high temperature and high pressure. However, unfortunately, after we finished a series of conductivity measurements, we did not obtain any available regular change with the content of biotite. All of these obtained results disclosed that the electrical conductivity for gneiss presented a regular variation of the total content of alkali- and calcium ions, which was not related to the content of biotite. According to previously published conductivity results for phlogopite single crystal by Li et al. (2016), they extrapolated that the main charge carriers are probably K+ and F−, and fluorine may play a critical role in electrical conduction. And furthermore, Dai et al. (2014) measured the electrical conductivities of granite with different chemical composition at high temperature and high pressure, and they also adopted the total content of alkali- and calcium ions to establish one functional relationship of electrical conductivity and chemical composition. As we known, the mineralogical assemblages (main rock-bearing minerals are quartz, plagioclase and biotite) between granite and gneiss are almost same. In addition, the activation enthalpies for granite (0.44∼1.18 eV) by Dai et al. (2014) were very approximate to our present obtained results (0.35∼0.87 eV) for the gneiss samples at relevant temperature regions, and the charge carriers of granite were supposed to be K+, Na+ and Ca2+. So, in the present studies, the main contributor for conductivities of gneiss samples is related to K+, Na+ and Ca2+. As for the iron-related small polaron conduction, it is also of one popular conduction type that Fe-bearing silicate minerals and rocks, such as olivine, pyroxene, garnet etc. (Xu et al. 2000; Wang et al. 2006; Dai et al. 2009; Yang et al. 2012). For these Fe-bearing silicate minerals with small polaron conduction, previous studies have confirmed that the conductivities decrease with the increase of pressure (Xu et al. 2000; Dai et al. 2009; Yang et al. 2012). At present studies, the conductivities of the gneiss samples increased with the rise of pressure. Therefore, we can conclude that the dominant charge carrier for gneiss is possibly not electron but ions.

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Please also note the supplement to this comment:
https://www.solid-earth-discuss.net/se-2017-103/se-2017-103-AC4-supplement.pdf

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