Responses

Key Laboratory of High-temperature and
High-pressure Study of the Earth's Interior,
Institute of Geochemistry,
Chinese Academy of Sciences,
No 99, Linchengxi Road, Guiyang City,
Guizhou Province, P. R. China, 550081
Email address: dailidong@gyig.ac.cn
Fax number: 86-0851-85891749
February 6th, 2018

Dear the editor of Professor Ulrike Werban:

We have already completed revisions on our manuscript, which is Manuscript Number SE-2017-103 entitled "Effect of chemical composition on the electrical conductivity of gneiss at high temperatures and pressures" by Lidong Dai, Wenqing Sun, Heping Li, Haiying Hu, Lei Wu and Jianjun Jiang, submitted to *Solid Earth*. Above all, we thank the Editor of Professor Ulrike Werban, Professor Fabrice Gaillard and two anonymous reviewers for their very constructive and enlightened comments and advisements in the reviewing process, which helped us greatly in improving the manuscript. In this revised paper, we conscientiously read through all comments from the editor's and three anonymous reviewers' valuable suggestions, and revised them points by points, sentences by sentences. All of correspondent revisions and responses are listed in the section of Revision Notes.

Thank you very much again for many kind comments and suggestions from the Editor of Professor Ulrike Werban, Professor Fabrice Gaillard and two anonymous reviewers to put forward a large amount of crucial and constructive suggestions to greatly improve our manuscript. We made great efforts answering all of these questions one by one opinions, and revising the manuscript points by points, sentences by sentences, accordingly. The revised manuscript has been significantly improved, and hope it is now acceptable for your publication in *Solid Earth*.

With best Regards,

Lidong Dai, PhD, Corresponding author

Revision Notes

Response to the anonymous Reviewer 1#:

The manuscript has been consolidated significantly. I now just have some less important comments.

1. The descriptions in lines 74-75 are not pertinent. Why the protolith of gneiss is granite? This is basically incorrect. The description should be careful.

Thanks for your valuable comments. Indeed, just as described by the first anonymous reviewer, as a complex rock for gneiss, it is not related with our present title "Effect of chemical composition on the electrical conductivity of gneiss at high temperatures and pressures". And therefore, we removed the content of descriptions in lines 74–75 in the revised manuscript.

2. I think "Therefore, in the… by changing the total alkali and calcium ion content" is not necessary and also not suitable. There are total 3 experiments. All the samples are just natural ones, no special efforts are adopted to synthesize samples with different alkali composition. The experimental results can be, but maybe occasionally, explained by the total alkali and calcium components. Therefore, not necessary to emphasize that you measure the conductivity by changing the total alkali and calcium ion content.

Thanks for your valuable and professional comments and suggestions. In the present studies, the electrical conductivity was conducted for three natural gneisses with different alkali composition rather than hot-pressed synthetic samples in main consideration that the natural rock samples become more representative to explore its geophysical implications. Of course, in the section of sample preparation, the sentence is a little duplicated and was deleted in the revised manuscript.

3. What is F^+ in line 287?

Thanks for your conscientious corrections. I have already corrected F^+ into F^- in line 287.

4. The activation energy from 0.5 to 2.0 GPa should be stated in Table 3.

Thanks for your valuable comments. According to your precious comments, we have already supplemented the activation energy values at the pressure range of 0.5 to 2.0 GPa in Table 3 and the calculated equation in the context of the revised manuscript.

5. What kind of difference in mineralogical assemblage and chemical composition between gneiss and granite in line 326-327? The authors should show it rather than just mention it.

Thanks for your valuable comments. The main minerals of our gneiss samples are plagioclase, quartz and biotite (Table 1). Dai et al. (2014) studied the electrical conductivity of natural granite with various chemical compositions at 623–1173 K and 0.5 GPa. The main rock-forming minerals of the granite sample are also plagioclase, quartz and biotite. However, the biotite content of the granite sample is smaller than the content of gneiss. For chemical compositions, the contents of SiO_2 in the gneiss samples are lower than those in the granite samples; the contents of calc-alkali ions in the gneiss samples are close to those in the granite samples. Therefore, the dependence of electrical conductivity of gneiss on chemical composition is not identical to granite.

6. Are there studies to interpret the high conductivity anomalies within Dabie-Sulu by fluids or melts?

Thanks for your valuable and professional comments and suggestions. From the field geophysical observations, previously magnetotelluric results have already confirmed that it is widely existed the high conductivity anomalies within Dabie–Sulu ultra-high pressure metamorphic belt and interpreted the cause of the high conductivity anomalies by partial melting and water–bearing (or saline–bearing) fluids (Xiao et al., 2007). From the viewpoint of geochemistry, some stable isotope geochemical evidences have also disclosed that the water–bearing (or saline–bearing) fluids and partial melting phenomena were widely observed in the Dabie-Sulu ultra-high pressure metamorphic belt (e.g. Zheng et al., 2003; Zhao, Z., and Zheng, Y.: Remelting of subducted continental lithosphere: Petrogenesis of Mesozoic magmatic rocks in the Dabie-Sulu orogenic belt. Science in China Series D: Earth Sciences, 52, 1295–1318, 2009). In comprehensive consideration of Professor Fabrice Gaillard's comments, the Himalaya–Tibetan orogenic system with similar formation conduction and geotectonic environments was selected to compare it with the Dabie–Sulu UHPM belt in order to explain the high electrical conductivity anomalies for Dabie–Sulu ultrahigh pressure metamorphic belt. However, the direct experimental evidences of the laboratory-based high-pressure measurements for the interpretation of the high conductivity anomalies within Dabie–Sulu ultrahigh pressure metamorphic belt by fluids or melts are scarce.

Response to Professor Fabrice Gaillard:

1. I think the author have conducted a great deal of effort to change the ms. Only minor typos or mistake are spread within the ms: (eg. line 45: of instead of "for"; line 49: number instead of "quantity"; remove the 's line 63 of use mineralogical assemblage of granulite...).

Thanks for your conscientious corrections. I have already corrected them one by one very carefully in the revised manuscript.

2. I don't like the new title as "complex impedance spectroscopy" is not speaking to anyone.

Thanks for Professor Fabrice Gaillard's valuable and professional comments. We have changed the title into the initial one "Effect of chemical composition on the electrical conductivity of gneiss at high temperatures and pressures".

3. *Regarding the last sentence that the high conductivity at Dabie-Sulu may be due to deep fluids or melts, is there any geological evidence for a magmatic activity in this*

area (eg granitic rocks or volcanoes)?

Thanks for your valuable and professional comments and suggestions. From the field geophysical observations, previously magnetotelluric results have already confirmed that it is widely existed the high conductivity anomalies within Dabie–Sulu ultra-high pressure metamorphic belt and interpreted the cause of the high conductivity anomalies by partial melting and water–bearing (or saline–bearing) fluids (Xiao et al., 2007). From the viewpoint of geochemistry, some stable isotope geochemical evidences have also disclosed that the water–bearing (or saline–bearing) fluids and partial melting phenomena were widely observed in the Dabie-Sulu ultra-high pressure metamorphic belt (e.g. Zheng et al., 2003; Zhao, Z., and Zheng, Y.: Remelting of subducted continental lithosphere: Petrogenesis of Mesozoic magmatic rocks in the Dabie-Sulu orogenic belt. Science in China Series D: Earth Sciences, 52, 1295–1318, 2009). In comprehensive consideration of Professor Fabrice Gaillard's comments, the Himalaya–Tibetan orogenic system with similar formation conduction and geotectonic environments was selected to compare it with the Dabie–Sulu UHPM belt in order to explain the high electrical conductivity anomalies for Dabie–Sulu ultrahigh pressure metamorphic belt. However, the direct experimental evidences of the laboratory-based high-pressure measurements for the interpretation of the high conductivity anomalies within Dabie–Sulu ultrahigh pressure metamorphic belt by fluids or melts are scarce.

4. Figure 8: please try to make the symbols and lines for this study easier to see.

Thanks for your precious comments and suggestions. We have already tried my best to reedit, decorate and adjust Figure 8 that the symbols and as well as the artistic contrast of line in the shapes and color make it more clear and easily understood in the revised manuscript.

5. In fig 10 at 30 km the gneisses reach the electrical conductivity of 0.1 S.m, which corresponds to an electrical anomaly; what is the temperature at such a depth, then? is it possible to have such a temperature at 15 km? Would it implies melting?

Thanks for your valuable and professional comments and suggestions. According to previous study, the relationship between temperature and depth in the Earth's stationary crust can be obtained by a numerical solution of the heat conduction equation (Selway et al., 2014):

$$T = T_0 + \left(\frac{Q}{k}\right)Z - \left(\frac{A_0}{2k}\right)Z^2 \tag{4}$$

where T_0 is the surface temperature (K), Q is the surface heat flow (mW/m^2), Z is the lithosphere layer depth (km), k is thermal conductivity (W/mK), and A_0 is the lithospheric radiogenic heat productivity (μW/m^3). Based on previous studies, the corresponding thermal calculation parameters for the Dabie–Sulu orogen are Q=75 mW/m^2 (He et al., 2009), A_0=0.31 μW/m^3 and k=2.6 W/mK (Zhou et al., 2011). Based on the heat conduction equation and the corresponding thermal calculation parameters for the Dabie–Sulu orogen, the depths of 30 km and 15 km are corresponding to 1113 K and 720 K, respectively. In light of temperature gradient, the depth of 15 km can't reach a relatively high temperature of 1113 K. Therefore, the partial melting of gneiss is impossible to occur at the depth of 15 km with a relatively lower temperature of 720 K (Dai et al., 2014; Fuji-ta et al., 2007). Just described by Xiao et al. (2007), a large amount of granites is outcropped in the Yanshanian intrusive rocks of Dabie–Sulu ultra-high pressure metamorphic belt, and the granites are formed in the deeply upper mantle. Previously reported results from field magnetotelluric data have already disclosed that the high conductivity anomalies in the Dabie–Sulu orogen are interpreted as the cause of the partial melting and water–bearing (or saline–bearing) fluids.

Response to the anonymous Reviewer 3$^{\#}$:

After a careful reading of the revised manuscript, I found that my suggested corrections were taken into account and incorporated properly and thus, the overall picture improved significantly, both in scientific terms and in terms of the quality of the English language. I notice 2 minor changes that should be taken into consideration:

1. First, the authors should give the equation for the calculation of activation volumes (line 303).

Thanks for your valuable comments. According to your precious comments, we have already supplemented the activation energy values at the pressure range of 0.5 to 2.0 GPa in Table 3 and the calculated equation in the revised manuscript.

2. Second, in Table 3, the authors should explain the parameters, and change the symbol of the correlation coefficient to R. I suggest that the revised manuscript will make a significant contribution to the field of geophysical implications of laboratory conductivity measurements and it is suitable for publication in Solid Earth.

Thanks for your valuable comments and suggestions. The fitted equation and explanation of the parameters have been already supplemented in the revised manuscript. Meantime, the symbol of correlation coefficient of R has been corrected.

In summary, the Editor of Professor Ulrike Werban, Professor Fabrice Gaillard and two anonymous reviewers put forward many preciously constructive and enlightened comments and advisements. In the revised paper, we try my best to answer all of them and present a detailed response one by one, very carefully. Each correspondent context content, figure, table and reference has been rechecked and reedited very carefully on the base of the officially announced publication format from the journal website of Solid Earth. In here, please accept my most honest greetings and thanks for my own heart to the Editor of Professor (Professor Ulrike Werban), Professor Fabrice Gaillard and two anonymous reviewers for their hard work in completing conscientious comments. At current, we think that a thoroughly substantial and great improvements have been made for the revised manuscript, and hope it is now acceptable for publication in *Solid Earth*.

With best Regards,

Lidong Dai, PhD, Corresponding author