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Solid Earth Discussions

Interactive comment on "Mineral leaching chemicals transport with runoff and sediment from severely eroded rare earth tailings in southern China" *by* Huizhong Lu et al.

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Dear editor,
We are very grateful for you and the reviewers' comments and suggestions about this paper. Those comments are very valuable and helpful for revising and improving our manuscript, as well as the important guiding significance for our researches.
According to these revision suggestions, we have carefully addressed the comments and made revision in detail as following.
Sincerely yours,
Huizhong Lu

Response to reviewer's comments
C1

Issues raised by Reviewer #1:
Question 1: P2L6 Furthermore, different chemicals have unique transportation pathways and primary carriers in runoff. Thus, it is necessary to compare the differences between NH_4^+ and SO_4^{2-}. The authors should added the reason why the paper studied NH_4^+ and SO_4^{2-} and their research progress.
Response: Thank you very much for your comments and suggestions. We added the reason why NH_4^+ and SO_4^{2-} were studied in P3L13: "As a large quantity of ammonium sulfate and ammonium bicarbonate were added in production process, NH_4^+ and SO_4^{2-} still remain in the REE mining region". We also added the research progress: "It is estimated that the process generates about 20-25000 t of wastewater and 300-500 mg/L total ammonia nitrogen concentration up until 2005 (Khan et al, 2016). NH_4^+ tends to be absorbed by soil, and excess NH_4^+ would accelerate soil acidification, reduce soil mineral element content, change soil solution ion composition and aggravate the soil contamination (Zhou et al., 2014). SO_4^{2-} is water soluble, and high concentration could lead to direct death for plants (Yang, 2009)." in P3L14-19.

Question 2: P2L9, Three rainfall events were recorded on June 16, 2012, May 15, 2013, and May 16, 2013. At least two samples were taken at every sampling point. There were a total of 67 rainfall runoff samples. Three rainfall events, eighteen sampling points, how to get a total of 67 rainfall runoff samples.
Response: Thank you very much for your comments. We are sorry for lacking of detailed field sampling information. For the rainfall events on June 16, 2012 and May 15, 2013, the rainfall duration is relatively short. Furthermore, the period to the last rainfall is long and soil moisture is in low condition. Therefore the surface runoff yield is relatively small and the duration is not long enough to take the repeated samples for all points along the flow routes in this study. In fact, we also took runoff samples in other smaller gullies, but the data is not included in this paper because the flow route is too short to show the difference.

Question 3: P7L25 N=31 in Figure 2(a) and N=24 in Figure 2(b), why are the two N different?
Response: Thank you very much for your comments. As we have mentioned previously, there was rare precipitation during a period before the rainfall event on May 15, 2013. Thus the soil moisture was very low. As SO_4^{2-} was mainly dissolved and transported with water. The low soil water content may influence the dissolve process and result in different dissolved SO_4^{2-} concentration. In this study, 7 samples within the gully which were taken in the early stage of the runoff process showed abnormal low SO_4^{2-} concentration. It might be related to a complex chemical mechanism that the absorbed SO_4^{2-} in soil particles transformed into dissolved SO_4^{2-}. In order to make sure the consistency between data of different rainfall events, we removed the 7 abnormal low values when conducting regression analysis in Figure 2(b). On the contrary, the following rainfall event (May 16, 2013) did not show abnormal low SO_4^{2-} concentration because of the high soil water content.

Question 4: P7L5 The precipitation intensities differed among the rainfall events, and the dissolved chemical concentrations increased with increasing precipitation intensity (Zhang et al., 2016). Thus, the data were standardized according to the precipitation intensites, i.e., the standardized concentrations were equal to the real concentrations divided by the corresponding precipitation intensity. P8L24. Each sediment samples was divided by into three sediment size groups: sand (2-0.05 mm), silt (0.05-0.002 mm) and clay (<0.002 mm). Maybe the sentences should be put in the 2.3 Analytical methods.
Response: Thank you very much for your valuable suggestion. We have made revisions accordingly. Please refer to the contents in 2.3 Analytical methods in P5L18 and P5L27.

Question 5: Some sentences should be put in the discussions. For example, P8L27

Smaller particles, particularly silt and clay, have relatively greater specific surface areas and can therefor adsorb and transport large quantities of chemicals.
Response: Thank you very much. We have made revisions according to your suggestions. Please refer to the contents in discussion section 4.2 "NH_4^+ and SO_4^{2-} transport dynamic in flow and sediment process" in P10L44.
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Question 6: There are some comparisons in the paper, for example, P6L13 The absorbed NH_4^+ concentrations at sites B (2.05 mg/L) and C (1.26 mg/L) were higher than the dissolved NH_4^+ contents at sites B (0.93 mg/L) and C (1.04 mg/L). Why not use one-way analysis of variance (ANOVAs) to compare differences among them?
Response: Thank you so much for your valuable suggestion. One-way analysis of variance (ANOVA) was used to compare the difference between the leaching chemicals at different locations using SPSS 19.0 for windows. Highly significant differences were observed between the dissolved and absorbed leaching chemicals. Please refer to the contents in 3.2 section in P6L31-33, P7L1-3 and P7L10-12.

Question 7: P10L5 Our results demonstrate that SO_4^{2-} absorption occurred rarely in the upper soil, although it was found in deeper soil layers. How to draw the conclusion that it was found in deeper soil layers?
Response: Thank you very much for your comments. We are sorry for this conclusion. In fact, we are conducting series related researches including the leaching chemicals contents in layered deposited sediment in the same site. Unpublished field data support the viewpoint that "SO_4^{2-} was found in deeper soil layers". However, as the conclusion is not perfectly fit the main object of this paper, we have removed it to make the conclusion more reasonable.

Question 8: P11L14 4.3 Implications and prospects of this study, some materials should be added to 4.3 to improve it.

Response: Thank you very much for this suggestion. The new section was improved as follow: The mineral leaching chemicals characteristics in rare earth tailing heaps were discussed in this study. The results of this study indicate leaching chemicals transport characteristics. There are other pollutants besides leaching chemicals. During mining and processing of REE, major environmental risk related with the behavior and removal of tailings, due to wastewater, chemicals, rare earth elements and high concentration sediment (Khan et al., 2016). The pollutants transport from mining area to surroundings soil and surface water bodies through surface runoff water. Even after mining activities stopped, the ecological environment still suffers a series of serious problems, such as deposited farmland by sediment due to soil erosion and damaged soil because of low pH and high chemicals concentration. Measures for soil erosion and soil remediation must be urgently taken within the mining area. Vegetation and mulches have been proved could effectively reduce runoff energy and trap sediment (Cao et al., 2015). Meanwhile, ditches and terracing also should be conducted to intercept runoff. Soil amendment and fertility can be applied to improve the soil quality. These practices may control the influence of leaching chemicals, rare earth elements and sediments to surrounding environment. Furthermore, there are also many other factors that influence pollutant transport behavior besides transport distance, e.g, the flow energy and topography factors. In the future researches, field simulated experiments would be conducted to establish the relationship between flow hydraulic parameters and chemical transport characteristics. All of these studies will provide scientific foundation for erosion control and soil management in rare earth tailings regions in southern China. Please refer to the contents in P11L23.

Question 9: Technical corrections, mg kg^{-1} was used in Figure 3, mg L^{-1} was used in Figure 2, while mg/kg and mg/L used in the text.
Response: Thank you very much for your comments. The unit mg kg^{-1} in Figure 3 was changed into mg L^{-1}. Please refer to the contents in P8L20. Meanwhile, mg/kg and mg/L were changed into mg kg^{-1} and mg L^{-1} throughout the paper.