Dear Editor,

We would like to resubmit our manuscript entitled “Evaluation of three halogens (Cl, Br, I) data of GSJ geochemical reference materials by RNAA” to Minerals.

In revising the manuscript, comments are all considered. Let us describe here how we responded to them one by one. The revised portions are shown in red in the revised manuscript. We believe that our responses satisfactorily meet the comments given by three reviewers.

Yours sincerely,
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Dear Reviewer 2
We highly appreciate thorough and constructive comments. Let us describe here how we responded to them one by one. The revised portions are shown in red in the revised manuscript.

This paper describes INAA and RNAA measurements of geological specimens, and compares results with literature values of the same techniques as well as those of a few other analytical techniques. The study shows the complexity of these measurements and the difficulty of harmonizing results from different techniques. This study uncovers problems and provides useful information for better experimental design in the future.

Main concern:

The only two overlapping measurements for the two standards JCp-1 and JSO-1 are important in this study. For JSO-1, INAA has good agreement with RNAA, but for JCp-1 does not. The authors attribute this to within-sample heterogeneity. This may or may not be the reason since INAA effectively takes a bulk average. Between-sample heterogeneity is another matter.

Please consider the following: JCp-1 has about double the mass of JSO-1, as noted by the discussion n 3.2.1. (In addition, JCp-1 has 4 times the Cl mass fraction of JSO-1). The RNAA values for JCp-1 are higher than INAA for all three elements, which would suggest that INAA could be losing singla due to gamma attenuation, which is likely proportional to sample mass.

Please discuss this and other possible reasons of bias due to mass quantities, which perhaps can be a topic of future study – control for sample mass and elemental abundance.

Response: As pointed out by reviewer, sample weight in JCp-1 used in INAA and RNAA are higher than those in JSO-1. Thus, the observed differences in Br and Cl between INAA data and RNAA data can be explained by neutron attenuation by sample during irradiation and self-absorption of gamma ray on sample in INAA. In the previous study which analyzed meteorites (e.g., Kallemeyn and Wasson, 1982), about 300 mg of meteorite was analyzed, which is larger than those in this study (about 70 mg). These data were in good agreement with data obtained using other analytical techniques. In this study, one and two samples were irradiated in INAA and RNAA, respectively. Thus, neutron attenuation by the sample during irradiation is not responsible for the observed differences. As gamma-ray peak of $^{128}$I (443 keV) has lower energy than those of $^{38}$Cl (1642 keV and 2168 keV) and $^{82}$Br (554 keV and 776 keV). The degree of self-absorption at a lower energy peak is higher than that at a higher energy peak. When the observed differences in Cl and Br can be explained by self-absorption of gamma ray, the difference in I between INAA and RNAA data can be seen, and the degree of difference in I should be higher than those in Cl and Br. As shown in Table 3, it cannot be seen. Thus, we reached the conclusion that the differences in Cl and Br between INAA data and RNAA can be due to the sample heterogeneity. We added this explanation in the revised manuscript.

A second request: Please add standard error of the mean to each line (red, black, and blue) in Fig. 1. The figure caption mentioned “shaded area” but it’s not seen in Fig. 1.
Response: We modified.

A third request: Please add a bit more of the INAA irradiation conditions. Estimated thermal neutron flux, and whether there is a flux monitor for each irradiation.
Response: We added a description of thermal neutron flux at 1MW and 5 MW operation in the section titled “Methods”. In INAA, samples and the three calibrators for Cl, Br and I were irradiated together. Thus, flux monitor was not used. A description was added in the section titled “INAA”.