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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Hydrochemical characteristics of the hot spring waters in the Kangding district related to the Lushan $M_\mathbf{S}$ 7.0 earthquake in Sichuan, China" *by* Z. Chen et al.

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I must apologize for responding the comments so late. Comment 1: - lines 87-91. Chemical types of spring waters The authors classificate the sampled waters in 7 groups using the Shoka Levs classification method, but they don,t explain what are the principal water rock interaction processes generating these types of water. Looking at the data it seems that there are 3-4 main types of water while the other types are probably the result of mixing processes between the main types. A Piper or Langelier Ludwig diagram could show better the possible mixing processes. Furthermore a study of speciation-saturation indexes is needed. Thank you very much

for this suggestion. The reply to each comment is as followed: The springs nos. 16-23 and 25 occur in granite (Figure 1), which had the similar higher concentrations of Na+ and HCO3− because of the interaction between water and granite as the Eq. (2), and the higher concentrations of Ca2+ and Mg2+ for samples from the springs nos. 19, 23-24 should be attributed to water-rock interactions between the underlying Devonian carbonate and groundwater as the Eq. (3) and (4). In addition, Cl− is known to be conservative and derive from the deep earth mainly (Chen et al., 2014). Chemical type for samples from the spring no. 16 was Na-Cl (HCO3), with the Cl− concentration as 336.2 mg/l (Table 1), which suggested upwelling of the deep-earth fluids into the spring, and resulted in high 3He/4He ratios (between 1.43 and 3.73Ra, Ra = 1.39 $\times$ 10−6) (Zhou, 2011) and high temperatures (between 80.0âĹŸC and 70.2âĹŸC) for the springs (Table 1). The spring no. 24 is found in Carboniferous carbonate, the main components of the samples were Ca2+, Mg2+ and HCO3− because of interaction between the groundwater and carbonate as the Eq. (3) and (4). 2NaAlSi2O3+3H2O+CO2→H2Al2Si2O3ïźŠH2O+4SiO2+2Na++HCO3-+OH- (2) CaCO3+H2O+CO2→Ca2++2HCO3- (3) MgCO3+H2O+CO2→Mg2++2HCO3- (4) We had calculated the speciation-saturation indexes of calcite in water samples from the springs by the formula proposed by Oddo and Tomson, 1982. The speciation-saturation indexes ranged from -3.9 to -4.8, which indicated calcite in water samples from the springs were unsaturated.

We had made the modification in the text. Comment 2: - lines 93-94 – "The hydrochemical parameters of the spring waters before and after the Lushan MS 7.0 earthquake evidently varied with the amplitudes ranging from -73.3 to 231.9 mg/L". This sentence is not clear, how can a concentration have a negative value (-73.3 mg/L). Thank you very much for this suggestion. The reply to each comment is as followed: "The values ranged from -73.3 to 231.9 mg/L" was the varied amplitude of hydrochemical parameters of water samples from the springs compared to their first batch of water samples. The hydrochemical parameters of some water samples decreased before and after the earthquake, so the varied amplitudes were negative.

We had made the modification in the text. Comment 3: -line 98 and Fig.3 – not clear why the Guanding waters show a decrease in Na and TDS but an increase in Ca and HCO3, dilution and simultaneous dissolution of calcite? Please explain better. Thank you very much for this suggestion. The reply to each comment is as followed: On the one hand, TDS of samples from the spring no. 16 increased as listed in the table, but we had made the mistake during drawing the diagram. So we have redrawn the diagram, and revised the text accordingly. On the other hand, the high 3He/4He ratios (between 1.43 and 3.73Ra, Ra= 1.39×10-6) of gas samples (Zhou, 2011) and high temperatures (between 44.8 and 83.0 C, Table 1) and concentrations of Na+, Cl- and SO42- of water samples (Chen et al., 2014) from the springs nos. 16, 18 and 21 suggested the contribution of mantle ïňĆuids into the springs. Therefore, the decrease of concentrations of Na+, Cl- and SO42- for samples from the springs nos. 16, 18 and 21 after the main shock may result from the influx of shallow waters depleted in Na+, Cl- and SO42- relatively. There was a strong smell of rotten egg from the spring no. 22, which indicated a considerable H2S content from the spring. Therefore, the increase of concentrations of Na+ and SO42- in samples from the spring no. 22 may be attributed to water-rock interactions between granite and groundwater enhanced by H2S as the Eq. (5). 2NaAlSi2O3+3H2O+H2S+4O2→H2Al2Si2O3+4SiO2+2Na++SO42- (5) We had made the modification in the text. Comment 4: - Fig 3 – Why the four diagrams of Fig.3 don,t show the full data set? In the Ca diagram are shown the data of 7 springs (but only 3 for SO4), in the HCO3 and TDS diagrams are shown the data of 6 springs and in the Cl and Na diagram only four springs are shown. Thank you very much for this suggestion. The reply to each comment is as followed: The data of samples from some springs had no obviously variations before and after the earthquake. In order to ensure the concision for the diagrams, the data with little variation were not shown in the diagrams. We had made the modification in the text. Comment 5: - Conclusions. The observed changes in groundwater composition are clearly related to the seismic event, but are a consequence of the seismic event rather than a precursor of it. The authors talk invoke in general terms the water rock interaction processes in

order to explain some chemical changes, but show only the overall reaction of CaCO3 dissolution. Thank you very much for this suggestion. The reply to each comment is as followed: Actually, the latest data were measured in 2010, and there were no obviously hydrochemical variations before the main shock. However, the hydrochemical anomalies were observed 3-5 days after the main shock, and the amplitudes were obviously, as high as 231.9 mg L-1. Usually, hydrochemical anomalies related to earthquake can continue to about one month after the main shock (Du et al., 2008), such as those related to the Wenchuan ðİŚĂðİŚĘ 8.0 earthquake with the epicenter 300km northeast to that of the Lushan ðİŚĂðİŚĘ 7.0 earthquake (Chen et al., 2014). Therefore, the observed hydrochemical anomalies after the Lushan ðİŚĂðİŚĘ 7.0 earthquake could be the continued precursory related to the main shock. In addition, 36 aftershocks with ðİŚĂL higher than 4.0 occurred within 5 days after the main shock. Therefore, the aftershocks could have play an important role in producing the hydrochemical anomalies observed after the main shock. We had made the modification in the text. Comment 6: TECHNICAL CORRECTIONS Fig.3 – The ïňĄgure show four diagrams. Please add a, b, c, d, to the diagrams. Thank you very much for this suggestion. The reply to each comment is as followed: We have added a, b, c, d, to the diagrams.

Please also note the supplement to this comment:
http://www.nat-hazards-earth-syst-sci-discuss.net/2/C3574/2015/nhessd-2-C3574-2015-supplement.pdf

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 7293, 2014.

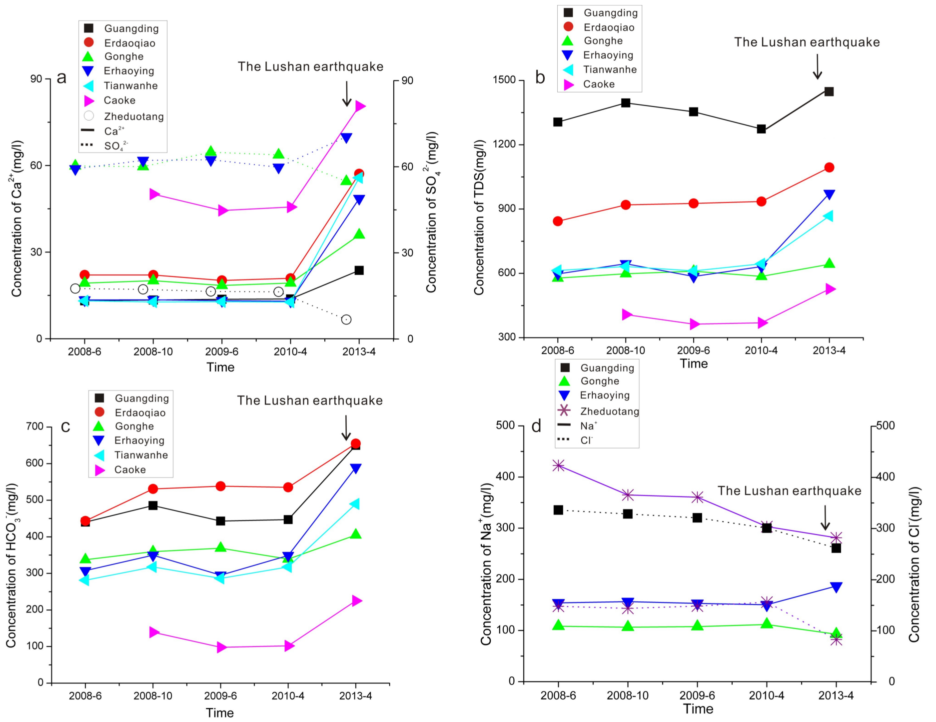

Fig. 1. Fig. 3. Temporal ion variations of the spring waters before and after the Lushan earthquake.