Response mechanism of hydrochemical changes in Puer observation well before earthquakes in Yunnan, China

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Tectonic activity usually can be reflected on the changes of hydrochemical ions in seismic fluid observation wells. Analyzing and studying the response mechanism of ion change in observation wells can help us to achieve the possible signal of earthquake prediction. The Puer observation well in Yunnan, China, has been continuously observing the pH value and the ion concentration of magnesium ion, calcium ion, bicarbonate ion and fluoride ion from May 1999, which was measured once a day at the same time and same method. Similar hydrochemical characteristics were captured before the Jinggu M_S6.6 earthquake in 2014 and the Mojiang M_S5.8 earthquake in 2018. It was probably that the upwelling of acid materials derived from crust resulted in the decrease of pH value, followed by the neutralization of cations, which results in the decrease of Ca and Mg ions concentration. Then earthquakes usually occurred when Ca and Mg ions concentration return slowly to high values.

From September 2018, Ca ions concentration decreased rapidly, followed by the decrease of HCO_3^- concentration and water temperature. It was speculated that calcium carbonate precipitation occurred, and CO_2 gas from deep crust-derived maybe reduced. Subsequently, with the decreasing Ca ions concentration, HCO_3^- and pH value did not decrease. That should be some exogenous anion replaced HCO_3^- to react with Ca^{2+}, because the precipitation kept existed due to the decreasing water temperature. Until the end of November, Ca and Mg ions concentration increased, precipitation still occurred because of the falling water temperature. When HCO_3^- concentration dropped further, the water temperature and the concentration of Ca and Mg ions were stable, there must be a balance between the increase of Na ions and the increase of SO_4^{2-} or Cl^- to keep the ionization equilibrium. Now it should be the result of the joint input of deep and superficial materials. Although there have been three stages of structural response changes, tectonic movement has not caused earthquakes. So it is more likely that the ion changes caused by the upwelling of deep acidic materials are the hydrochemical response mechanism of earthquake precursors for this well.

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