



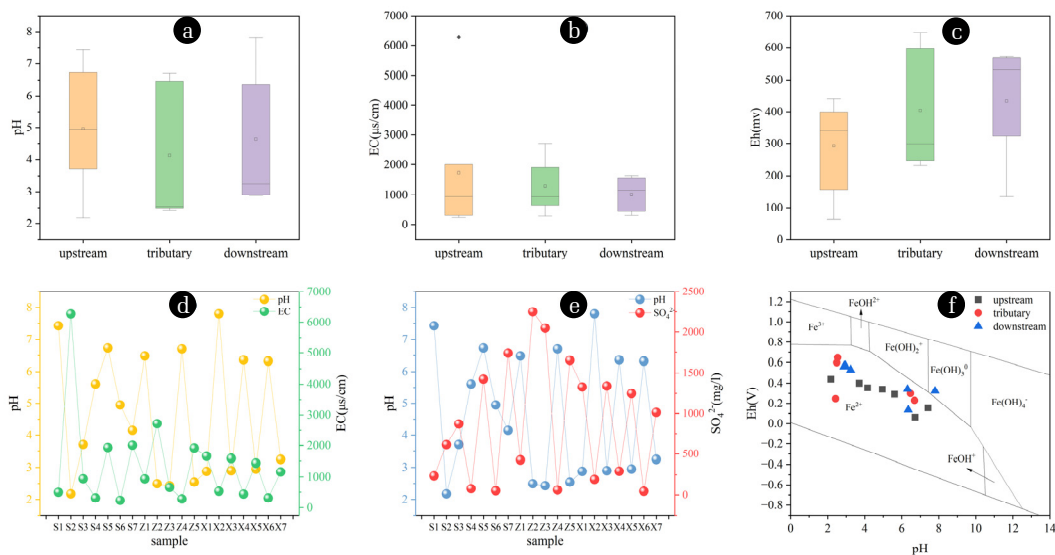
## Supplementary Materials

**Table S1.** Experimental instrument.

Laboratory Apparatus	Parameters
WTW(multi2620,Germany)	pH ,T(°C),Eh(mv),EC( $\mu\text{s}\cdot\text{cm}^{-1}$ )
ICE-3500 (Thermo Fisher Scientific USA)	$\text{Ca}^{2+}$ , $\text{Mg}^{2+}$ , $\text{Na}^+$ , $\text{K}^+$
ICS-1100 (Thermo Fisher Scientific USA)	$\text{Cl}^-$ , $\text{SO}_4^{2-}$ , $\text{NO}_3^-$ , $\text{F}^-$
ICP-MS (Thermo Fisher Scientific USA)	Fe, Mn, Sr, Cu, Zn, As, Sb, Pb, Se
LX-C(Weifang Hehai Hydrographic Technology Co. China)	Flow Velocity

**Table 2.** Various types of ion equivalency ratios

equivalence ratio	occasion	equation
$(\text{Ca}^{2+}+\text{Mg}^{2+})/\text{HCO}_3^- \approx 1$ $\text{SO}_4^{2-}/\text{HCO}_3^- \approx 0$	Only $\text{H}_2\text{CO}_3$ is involved in carbonate weathering	$\text{Ca}_x\text{Mg}_{(1-x)}\text{CO}_3+\text{H}_2\text{CO}_3 \rightarrow x\text{Ca}^{2+}+(1-x)\text{Mg}^{2+}+2\text{HCO}_3^-$
$(\text{Ca}^{2+}+\text{Mg}^{2+})/\text{HCO}_3^- \approx 2$ $\text{SO}_4^{2-}/\text{HCO}_3^- \approx 1$	Involvement of $\text{H}_2\text{SO}_4$ in carbonate weathering in the water column	$2\text{Ca}_x\text{Mg}_{(1-x)}\text{CO}_3+\text{H}_2\text{SO}_4 \rightarrow 2x\text{Ca}^{2+}+2(1-x)\text{Mg}^{2+}+\text{SO}_4^{2-}+2\text{HCO}_3^-$
$(\text{Ca}^{2+}+\text{Mg}^{2+})/\text{HCO}_3^- \approx 1.5$ $\text{SO}_4^{2-}/\text{HCO}_3^- \approx 0.5$	Both $\text{H}_2\text{CO}_3$ and $\text{H}_2\text{SO}_4$ are involved in mineral dissolution	$2\text{Ca}_x\text{Mg}_{(1-x)}\text{CO}_3+\text{H}_2\text{SO}_4+\text{H}_2\text{CO}_3 \rightarrow 3x\text{Ca}^{2+}+3(1-x)\text{Mg}^{2+}+\text{SO}_4^{2-}+4\text{HCO}_3^-$
Increase in $(\text{Ca}^{2+}+\text{Mg}^{2+})/\text{HCO}_3^-$ and $\text{SO}_4^{2-}/\text{HCO}_3^-$ equivalence ratios	Gypsum dissolution is present and dominates the water column	$\text{Ca}_x\text{Mg}_{(1-x)}\text{SO}_4\cdot 2\text{H}_2\text{O} \rightarrow x\text{Ca}^{2+}+(1-x)\text{Mg}^{2+}+\text{SO}_4^{2-}+2\text{H}_2\text{O}$



**Fig. S1.** Variation of pH, EC and Eh in the study area

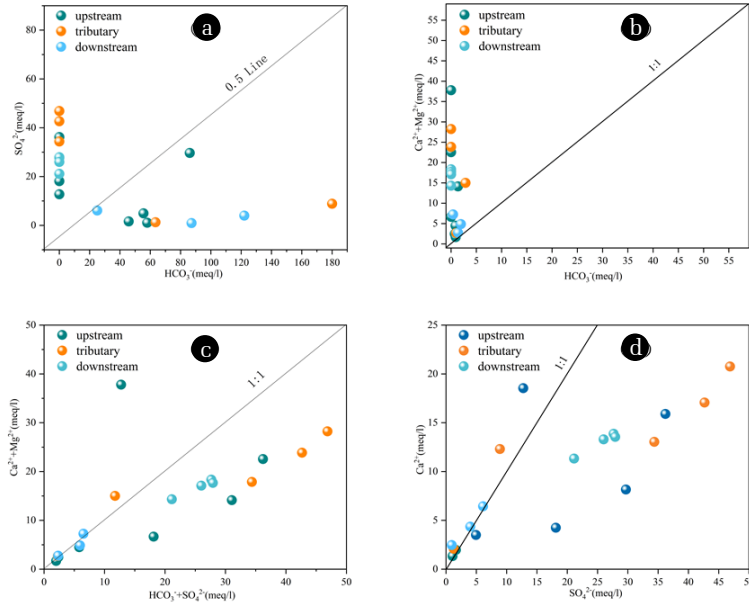


Fig. S2. Relationships between  $\text{SO}_4^{2-}$  and  $\text{HCO}_3^-$ ,  $\text{Ca}^{2+} + \text{Mg}^{2+}$  and  $\text{HCO}_3^-$ ,  $\text{SO}_4^{2-}$  and  $\text{Ca}^{2+}$ ,  $\text{Ca}^{2+} + \text{Mg}^{2+}$  and  $\text{SO}_4^{2-} + \text{HCO}_3^-$  in the study area

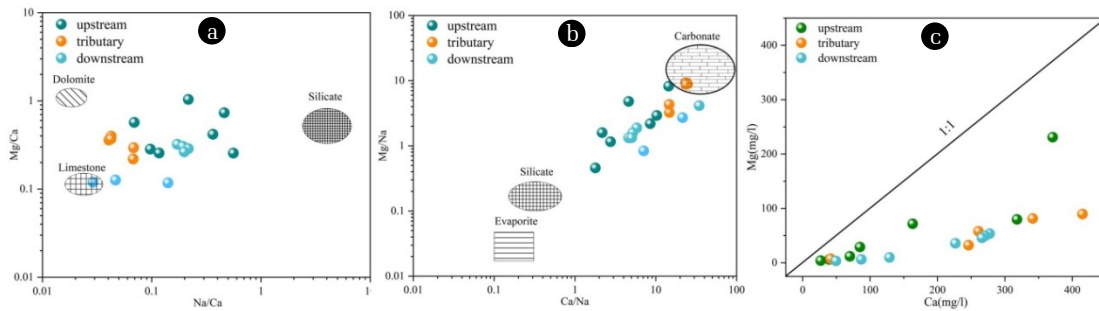


Fig. S3.  $\text{Mg}/\text{Na}$  and  $\text{Ca}/\text{Na}$ ,  $\text{Mg}/\text{Ca}$  and  $\text{Na}/\text{Ca}$  relationships in the study area

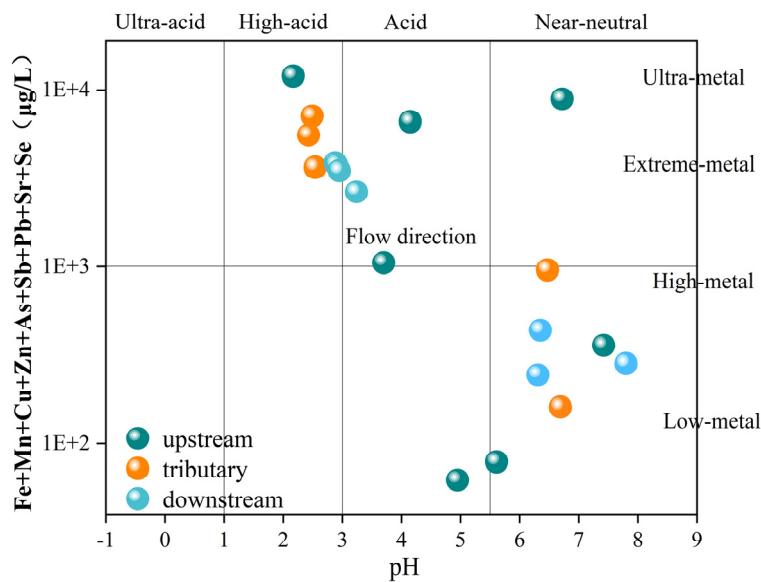


Fig. S4. Ficklin diagram