# Source and evolution path of ore-forming fluids in Volcanogenic Massive Sulfide (VMS) system: New constraint from lithium isotopic investigation on the Gacun deposit, Sichuan

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Lithium isotopic compositions of fluid inclusions and hosted gangue quartz from a giant volcanogenic massive sulfide deposit in China provide robust evidence for inputting of magmatic fluids into a Triassic submarine hydrothermal system. The $\delta^7$Li results vary from +4.5‰ to +13.8‰ for fluid inclusions and from +6.7‰ to +21.0‰ for the hosted gangue quartz(9 gangue quartz samples containing primary fluid inclusions). These data confirm the temperature-dependent Li isotopic fractionation between hydrothermal quartz and fluid (i.e., $\Delta\delta^7Li_{quartz\text{-}fluid} = -8.9382 \times (1000/T) + 22.22$($R^2 = 0.98$; 175 ℃–340 ℃)), which suggests that the fluid inclusions are in equilibrium with their hosted quartz, thus allowing to determine the composition of the fluids by using $\delta^7Li_{quartz}$ data. Accordingly, we estimate that the ore-forming fluids have a $\delta^7$Li range from -0.7‰ to +18.4‰ at temperatures of 175–340°C. This $\delta^7$Li range, together with Li–O modeling , suggest that magmatic fluid played a significant role in the ore formation. This study demonstrates that Li isotope can be effectively used to trace magmatic fluids in a seafloor hydrothermal system and has the potential to monitor fluid mixing and ore-forming process.