

Volumetric properties of CO₂-rich mixed fluids near critical regions

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The application of supercritical CO₂ (SC CO₂) is crucial for the Carbon Capture and Storage (CCS) big problem in earth environment science [1]. The physical and chemical properties of CO₂-rich mixed fluids are significantly different from that of pure CO₂ near critical regions. One of the important mixture's parameters is the excess volume [2]. It can be used to reflect the mutual dissolvability of components in the system. Acetone is a polar solvent while pentane is a non-polar one and they are typical organic co-solvents in supercritical CO₂ applications. Unlike high-pressure vapor-liquid equilibrium data, the densities and volumetric properties for CO₂-rich fluids with acetone and pentane mixtures near critical regions are very limited.

We have studied phase behavior and local density enhancements in CO₂ mixtures in various phase regions [3-7]. In this work, we focus on the comparison of volumetric properties for CO₂-rich binary and ternary mixed fluids with polar and non-polar co-solvent near critical regions where the most character of mixture is changeful. It shows that the excess molar volumes are all negative under pressure from the phase separation point to 15 MPa and become less negative with increased pressure. At fixed temperature and composition, the densities of CO₂-rich fluids with more acetone are bigger than with pentane and the excess molar volumes are more negative. At the same temperature, the excess molar volumes of mixtures with different critical composition are almost the same. The excess molar volumes of mixtures with different compositions have the similar behavior and become more negative with decreased CO₂.

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Stable isotopic composition of Zn in hydrothermal spring waters

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Recent studies have demonstrated the interest of Zn isotopes for investigating water-rock interactions. Speciation-related fractionation as well as source-related fractionation between its isotopes (about 2‰ in $\delta^{66}\text{Zn}$ unit) make Zn isotopes a promising tracer for studying the mobility of metals during weathering, hydrothermalism and ore formation. Although previous studies have focused on the processes fractionating Zn isotopes in hydrothermal solid deposits and seafloor vents, the Zn isotopic composition of hydrothermal waters in continental arc setting have not been investigated so far.

Hydrothermal springs from nine main rivers of the La Soufrière de Guadeloupe volcanic area (French West Indies) have been collected for Zn isotopic measurement. These samples display generally low dissolved Zn concentration (from 1 to 33 $\mu\text{g/L}$) despite their enrichment in iron and sulfate concentrations. We have developed a new one-step protocol for direct ion-exchange separation of Zn from thermal spring waters. The protocol is proven to be reproducible by tests on synthetic solution, with an average yield close to 100% and no isotopic fractionation.

$\delta^{66}\text{Zn}$ values of spring samples show a big variation range (from -0.43‰ to 0.80‰), being 70% of total variation of $\delta^{66}\text{Zn}$ data reported to date (from -0.43‰ to 1.33‰) for hydrothermal system, and an interesting correlation with Zn concentration for these samples. Isotopic characterizations of Zn in hydrothermal spring waters provide important information for studying hydrothermal processes and island arc weathering.