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Current state of springs and genetic diversity of high PCO_2 mineral waters of Primorsky Krai

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Abstract. We present the results of a comprehensive study of high PCO_2 mineral waters of Primorsky Krai, aimed at identifying their genesis and conditions of formation. For the first time, a joint analysis of the chemical and micro component composition of water, the gas phase (CO_2, N_2, CH_4, H_2, He, and Ar), and stable isotopes of oxygen and hydrogen ($\delta^{18}O$, $\delta^{2}H$) was carried out for a number of poorly studied springs, gained either during this study or previously by our group. Three genetic groups of waters were identified based on hydrogeochemical data: 1) Ca-HCO_3 type waters (Bolshoy Klyuch and Fabrichny springs) formed in terrigenous strata; 2) deep silicate-type waters (Pokrovsky and Glukhovka springs) associated with interaction with crystalline basement rocks and enriched with lithium, rubidium, and barium; 3) acidic waters of the sulfide oxidation zone (Nerobinsky spring), which are indicators of ore mineralization; 4) mixed-type waters showing the features of the three types described above. Gas-geochemical studies confirmed the predominance of CO_2 of mantle genesis (>96.9 vol.%) and the redox environment. Unique anomalies were identified, such as a high methane content (up to 2.26 vol.%) in the Pokrovsky spring, indicating possible thermogenic processes. The isotopic composition of the waters ($\delta^{18}O$ from –14.71 to –8.70 ‰, $\delta^{2}H$ from –103.79 to –60.28 ‰) clearly indicates their meteoric origin from cold climate precipitation, while the shift relative to the global meteor line indicates intensive isotope exchange in the water–rock–gas system. The results of the study are of fundamental importance for understanding the fluid dynamics of the Sikhote-Alin subsurface and can be applied for expanding the mineral resource base, developing balneology, and conducting geological prospecting in the Primorsky region.

Keywords:
mineral water, high PCO_2 waters, Primorsky Krai, water geochemistry

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