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Hydrothermal mineralization of celadonite: Hybridized fluid–basalt interaction in Janggi, Korea

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Abstract

The origin of celadonite still remains enigmatic and fragmentary. Exceptional celadonite mineralization was discovered in the Miocene lacustrine Janggi Basin in the southeastern Korean Peninsula. This Janggi celadonite is a greenish, earthy/vitreous material filling east-west trending fault zones in basaltic flows. The scale of the celadonite body is up to a meter thick and laterally extends ~10 m. These occurrences are markedly in contrast with celadonite as vesicle-filling or mineral-replacing types in the literature. The Janggi celadonite allows exploring the puzzling genesis of celadonite and comparing its characteristics with global cases for a better understanding of celadonite formation.

X-ray diffraction and microprobe analyses demonstrate that the Janggi celadonite ranges from ferroceladonite through celadonite to ferroaluminoceladonite and is mixed with opal at a ratio of up to ~3:7. Detailed fieldwork and whole-rock major, trace, and oxygen isotope analyses indicate that celadonite is formed in an open system at ~120 °C by the interaction of hybridized fluid (a mixture of <55% magmatic and >45% other origins) and basalts during the physicochemical fault brecciation of the host rock. The cations needed for celadonite formation were supplied from the smectitization/zeolitization of rhyolitic mesostasis (for Al and part of K) and pyroxene microlites (for Fe and Mg) in the basaltic breccias during the associated oxidation of micro-nanoparticles by circulating fluids (for most of K).

A comparison of the Janggi celadonite with global cases highlights that celadonite genesis is neither limited to the seawater alteration of basalt nor do hosts and reactive fluids control celadonite compositions. A contextualized perspective on celadonite genesis alludes that a potassic alteration of rock that is rich in ferromagnesian components in a shallow crustal environment (<~200 MPa at <~450 °C) produces celadonite. Because of the relative availability of the necessary components for celadonite precipitation, our model predicts celadonite mineralization in many volcanic environments, where magmatic fluid and particle size reduction could contribute. These insights emphasize celadonite's potential applications for tracing geothermal history.

Keywords: Celadonites, hydrothermal mineralization, fault brecciation, fluid–rock interaction, oxygen isotope