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Polyphase solid-inclusions formed by interactions between infiltrating fluids and precursor minerals enclosed in garnet of UHP rocks from the Dabie Shan, China

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Abstract

Three types of polyphase solid-inclusions (PSIs) with distinct mineral assemblages and microstructures were found in garnet of an ultrahigh-pressure (UHP) eclogite-vein system from the Dabie Shan, east-central China. Type-1 PSI contains variable volumes of quartz, K-feldspar, plagioclase ± other phases, whereas Type-2 PSI contains variable volumes of quartz, calcite ± other phases. Both types display shapes that are compatible with those of euhedral coesite inclusions. Type-3 PSI always contains a rutile core that is surrounded by plagioclase ± quartz and generally displays the morphology of the rutile core. Variable amounts of K-feldspar are embedded within the plagioclase of Type-3 PSIs. The three PSI types developed fluid-mediated microstructures that include wedge-like offshoot and protrusion textures and inclusion-garnet interfaces controlled by the crystallographic structure of garnet. PSIs in peak minerals of UHP rocks have been previously thought to represent primary supercritical fluid or melt inclusions. Here we propose that the studied PSIs were formed under high-pressure (HP) eclogite-facies conditions during exhumation and represent reaction products between an enclosed mineral, such as coesite and rutile, and external fluids infiltrating the host garnet along fractures that have been healed later on. Two immiscible aqueous fluids (i.e., a siliceous and a carbonaceous) were involved in the formation of these PSIs. The siliceous fluid was rich in various large ion lithophile elements like Cs, Rb, Ba, K, Pb, Li, and Sr, whereas the carbonaceous fluid was rich in Pb and Sr. The new PSI formation mechanism proposed in this study brings significant implications for tracing fluid evolution and post-entrapment modifications of mineral inclusions in HP and UHP metamorphic rocks.

Keywords: Dabie Shan, ultrahigh-pressure, coesite, polyphase solid-inclusion, fluid-rock interaction