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A high-resolution geochronological and geochemical study on Aegean carbonate deposits, SW Turkey

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Vein and breccia carbonates precipitated in highly fractured/faulted carbonate bedrock were investigated using high-resolution U-series geochronology, as well as through microstructural and geochemical studies including Sr-O-C isotope and REE element analyses.

The study area (Kumlubük and Amos vein systems), located south of the town of Marmaris in SW Turkey, is a part of an active large-scale extensional system. Field studies show that the calcite veins generally occur sub-vertically and strike mostly NW and EW, in agreement with the regional N-S extensional stress regime. Microscopic observations indicate that the calcite veins formed through crack-seal mechanism, typically accompanied/initiated by intensive hydraulic fracturing of wall-rock evidenced by the presence of widespread breccia deposits. Vein textures are dominated by elongated, fibrous, and blocky calcites. Successive fracturing and layering of calcite with sharp contacts are traceable along the fluid inclusion bands occurring parallel to the wall rock boundary. In particular, inclusion trails aligned perpendicular to the wall-rock and calcite crystal elongation give information about the vein dilation (crack opening) vector and growth direction.

High-resolution U-series dating (11-272 ka BP) and geochemical compositions of the vein and breccia samples were used to investigate the long-term behaviour as well as the general identity of the CO_2-bearing fluids within deformed crust. The seismic nature of calcite veining is further assessed by stable isotopic ratio (δ^{18}O and δ^{13}C) plots against vein depths (distance from the wall-rock). The average $\delta^{18}O_{PDB}$ value for Kumlubük veins is -3.79‰, while Amos has an average value of -4.05‰. Similarly, average carbon isotope ratio (-8.30‰) of the Kumlubük veins is slightly higher than that is observed for the Amos veins (-9.66‰). Isotopic compositions are interpreted to reflect cyclic (or episodic) CO_2 variations. This suggests the presence of several fluid sources and mechanisms (e.g. luid-rock interaction) indicating the significance of pressure and temperature controls on the evolution of the CO_2_bearing fluid system. Sr-isotope ratios (^{87}Sr/^{86}Sr: 0.7082-0.7085) in combination with REE compositions are used to trace fluid sources. REE data of the veins from both regions show typical seawater signatures with distinct negative Ce and positive Y anomalies, which corresponds well with the REE composition of the host limestone. While majority of the samples show similar PAAS-normalised REE variations, some of the veins further display positive Eu anomalies, which could be indicative of contribution from a deeply derived, hot, and reduced fluid component.