UHP-UHT melting and diamond formation

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Exhumed ultrahigh-pressure (UHP) terranes, involving slices of deeply subducted crustal rocks, provide unique material for studying material transfer in subduction zones. Diamond-bearing UHP rocks with sedimentary protoliths allow for tracing melting processes at both UHP and UHT including carbon cycling in the Earth. We studied microdiamonds and associated phases in two contrasting lithologies, (1) acid, quartzofeldpathic UHP gneiss composed of garnet, kyanite, feldspar, quartz and biotite, with a high ASI characteristic of sedimentary rocks, and (2) intermediate garnet-clinopyroxene rock containing quartz, feldspar, minor kyanite and biotite, which is metaluminous. Whereas rock (1) contains exclusively single octahedral diamonds with perfect crystal shape in garnet, kyanite (more common) and zircon, the microdiamonds in the rock (2) occur mostly as clusters of cuboid shape in garnet and zircon. Micro-Raman and FIB TEM data document presence of graphite, quartz and rutile at diamond/host interface or in separate multiple solid inclusions (MSI) whereas carbonates are practically absent. The morphology and lack of inclusions reflect relatively slow growth of the octahedral diamonds (rock 1) at lower fluid supersaturation. Individual deep and symmetrical negative trigons (AFM) on the (111) plane suggest dissolution by a residual silicate-carbonate melt. In contrast, polycrystallline character of diamond cuboids (rock 2) along with their common dissolution and formation of numerous tetragonal etch pits reflect relatively rapid growth of these grains from highly supersaturated fluid/melt. Peak P-T conditions for the UHP rocks of ≥ 1100ºC at 4.5 GPa are located above the phengite dehydration melting curve, where silicate melts are produced and may coexist with carbonate melts. In view of the light carbon isotope composition and lack of carbonates, we suggest that the diamonds crystallized from the graphitized primordial organic matter under reducing conditions at presence of silicate melt.