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# Exotic zoned moissanite from metamorphic schists of Bulgaria: new constraints on moissanite formation

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Moissanite, SiC, discovered first in the Canyon Diablo meteor crater in Arizona, is considered as a rare terrestrial mineral occurring mostly as inclusions in diamonds and as xenocrysts in kimberlites. Until recently, it was considered by many researchers as a mantle mineral whose formation requires extremely reduced conditions of 4.5-6 log units below the IW fugacity buffer. In the 60s-70s, there were inexplicable reports of findings of SiC in pegmatites, granites, sedimentary rocks, and even in polymetallic deposits in the former USSR territories. Over the last decade, a number of publications have been devoted to new findings of SiC in chromitite and dunite in ophilolite formations, with suggestions of lower mantle origins. We present studies of unusual moissanites that occur in situ, in metamorphic rocks from Southern Bulgaria characterized by abundant plagioclase, micas, quartz, and minor garnet and staurolite. The 10-300 $\mu$m moissanite crystals are situated within 0.1-1.2 mm isolated clusters, filled with amorphous carbon and nanocrystalline graphite. Raman Spectroscopy and Focused Ion Beam assisted Transmission Electron Microscopy showed that the SiC crystals are presented by 6H-SiC polytype of hexagonal (wurtzite) structure, and 15R (rhombohedral) polytype. Unusual crystallographically well-developed prismatic crystal of SiC, found within them, exhibits concentric polytypical zoning with core (15R), intermediate zone (6H) and rim (3C-cubic). Experimental data show that this type of polytypical zonation is likely due to a decrease in temperature (or/and pressure?) and changes in Si/C ratio. Our research suggested that the core zone of the SiC formed under nucleation controlled rapid growth in the stability field of essentially 15R polytype. The intermediate (transition) zone was formed when nucleation rate was reduced, and the larger sizes of the formed lamellar domains are evidence of this. A change in the equilibrium conditions made it possible for concurrent formation of 6H and 15R polytypes. The 3C stability field was entered when the external thermodynamic parameters changed once again and that marks the formation of the exterior portion of the rim. The clusters, which contain SiC, are pre-metamorphic, and we hypothesize that their protolith was a "black shale" material likely rich in hydrocarbon and terrigenous silica. The latter served as a source of isolated chemically-reduced media, which is required for SiC formation.

There are more than 250 polytypes of SiC; however, no phase diagrams exist that clearly demonstrate the PT stability field of moissanite to be compatible with any possible geological environments where this mineral has been found. Our studies suggested that SiC should be considered as an accessory mineral which can be found in any type of rocks where a sufficiently reduced fluid environment and sources of Si and C are available. These rocks could occur in different places from the Earth's core all the way to the Earth's surface. Any new terrestrial samples of SiC in situ should be studied in details with advanced analytical techniques, followed by carefully designed experiments to understand the nature of the SiC in different geological environments.