

Ubiquitous moissanite (SiC) - from Earth's surface to core: insight through experiments and studies of natural samples

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Moissanite (SiC) is an important mineral of the carbides group for understanding crust-mantle processes of silicon and carbon interaction during deep subduction of continental material into the Earth's interior. The carbon cycle involving carbides (SiC and Fe_xC_y) has potentially significant implications for the study of early life on Earth. Moissanite was found in meteorite impact craters, as inclusions in kimberlitic diamonds, kimberlites and mantle xenoliths and was traditionally considered as a high-pressure mineral, though over the last decade, a number of publications have been devoted to new findings of SiC in chromitite from ophiolite formations and in other magmatic, metamorphic and sedimentary rocks with suggestions of lower mantle origins; or, alternatively, suggestions that SiC may have formed in the shallow Earth. In the 1960s-70s, there were inexplicable reports of findings of SiC in pegmatites, granites, sedimentary rocks, and in polymetallic deposits in the former USSR. Those SiC samples, however, were found only in heavy mineral separates, and therefore the relation of the SiC with other minerals remained uncertain and requires further re-examination. The most common feature for terrestrial SiC is that although its formation requires extremely reduced conditions of 4.5-6 log units below the IW fugacity buffer, it occurs in many cases within highly oxidized phases.

There are more than 250 polytypes of SiC; however, no phase diagram exists that clearly demonstrates the P-T stability field of moissanite to be compatible with any possible geological environment where this mineral has been found. Because of its considerable technological interest, different polytypes of SiC were synthesized in the laboratory over a wide range of temperatures (1400-2800 °C) at atmospheric pressure. Only rare experiments were carried out in the diamond-anvil cell showing that at 100 GPa the 3C-SiC polymorph undergoes a phase transition into a rocksalt-type structure with a volume reduction of 20.3 %, whereas the 6H-SiC did not similarly transform (Yoshida et al., 1983). Ekimov et al. 2000 showed that nanocrystalline SiC crystallized from a Si-melt at 7.7 GPa, at 900 °C, and another group of their experiments demonstrated that SiC incongruently melts at 2827 °C and 8 GPa.

A literature survey suggests that SiC can exist at a wide range of P and T, however, at this stage, there are no data on the phase transformation between cubic 3C-SiC and hexagonal 6H-SiC polymorphs, and therefore, we do not know whether a clear phase boundary exists and at what conditions. Studies of terrestrial moissanite from different geological formations suggest that SiC cannot be considered as an indicator of high pressures but rather of low oxygen fugacity. Detailed research on natural SiC samples in combination with spectroscopic and high resolution scanning and transmission electron microscopy should be continued and followed by experiments to understand the nature of this mineral.