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SiC-dominated ultra-reduced mineral assemblage in carbonatitic xenoliths from the Dalihu basalt, Inner Mongolia, China

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Abstract

SiC and associated ultra-reduced minerals were reported in various geological settings, however, their genesis and preservation mechanism are poorly understood. Here, we reported a SiC-dominated ultra-reduced mineral assemblage, including SiC, TiC, native metals (Si, Fe, and Ni) and iron silicide, from carbonatitic xenoliths in Dalihu, Inner Mongolia. All minerals were identified in situ in polished/thin sections. SiC is 20–50 μm in size, blue to colorless in color, and usually identified in the micro-cavities within the carbonatitic xenolith. Four types of SiC polytypes were identified, which are dominated by β-SiC (3*C* polytype) and 4*H* polytype followed by 15*R* and 6*H*. These SiC are featured by ^{13}C-depleted isotopic compositions ($\delta^{13}C$ = –13.2 to –22.8‰, average = –17.7‰) with obvious spatial variation.

We provided a numerical modeling method to prove that the C isotopic composition of the Dalihu SiC can be well-yielded by degassing. Our modeling results showed that degassing reaction between graphite and silicate can readily produce the low $\delta^{13}C$ value of SiC, and the spatial variations in C isotopic composition could have been formed in the progressive growth process of SiC. The detailed in situ occurring information is beneficial for our understanding of the preservation mechanism of the Dalihu ultra-reduced phase. The predominant occurrence of SiC in micro-cavities implies that exsolution and filling of CO_2 and/or CO in the micro-cavities during the diapir rising process of carbonatitic melt could have buffered the reducing environment and separated SiC from the surrounding oxidizing phases. The fast cooling of host rock, which would leave insufficient time for the complete elimination of SiC, could have also contributed to the preservation of SiC.

Keywords: Carbonatitic xenolith, silicon carbide, iron silicide, native metal, C isotopic composition