

# Melting relations of the Fe-Ni-S-C system and the formation of superdeep diamonds

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Superdeep diamonds derived from the mantle transition zone or the lower mantle have been found in recent years, while most diamonds are thought to form in the upper mantle between 150 and 200 km depth. Smith et al. (2016) discovered solidified Fe-Ni-S-C melt in the inclusions of CLIPPIR diamond, which is one of the superdeep diamonds, and concluded that these diamonds have formed from the metallic liquid in the slabs subducted into the mantle transition zone. In this research, we have performed high-pressure and high-temperature quench experiments of the Fe-Ni-S-C system to investigate diamond formation in the mantle transition zone.

High-pressure and high-temperature experiments were carried out at a pressure of 15 GPa and temperatures of 900-1400 K using a Kawai-type apparatus. Diamonds can coexist with Fe-Ni-S-C melt above 1400 K at 15 GPa. Although the maximum carbon solubility in the liquid coexisting with diamond decreases to 1.5 wt.% with increasing sulfur content up to 12 wt.%, the maximum carbon solubility increases with increasing sulfur content above 12 wt.%. Taking into consideration of the carbon content in the mantle, diamonds can be crystallized from the liquid alloy by supersaturation at 15 GPa when sulfur content in the liquid ranges from 5 to 15 wt.%.

Since the temperature of the mantle transition zone at 450 km depth (15 GPa) is higher than 1400 K, diamonds can form from the Fe-Ni-S-C melt. On the other hand, the diamond cannot form within the top of subducting slab, due to its lower temperature. Thus it is considered that CLIPPIR diamonds have formed in the ancient hotter slab. Meanwhile, in the case that the mantle transition zone has a basaltic composition, it is feasible that the eclogitic diamonds such as CLIPPIR diamonds have been crystallized from liquid alloy in the mantle transition zone.

Keywords: diamond, mantle transition zone, the Fe-Ni-S-C system, liquid alloy, subducting slab