

# Formation of natural diamond: an experimental perspective

R.W. LUTH, S.C. GUNN, S.M. EWANCHUK AND R.J. STEWART

C.M. Scarfe Laboratory for Experimental Petrology,  
Department of Earth and Atmospheric Sciences,  
University of Alberta, Edmonton, AB, Canada T6G 2E3;  
(robert.luth@ualberta.ca)

The classic high-pressure, high-temperature synthesis of diamond utilizes molten transition metals as solvent/catalysts. Given the evidence from inclusions in diamonds, and prevailing views on the range of  $fO_2$  in the Earth's upper mantle, it is unlikely that such melts facilitate formation of natural diamond. One avenue of research that has provided much valuable insight into the environments in which diamonds form is the study of inclusions entrapped in diamond, an area to which Jeff Harris has contributed so much. Another avenue is experimental, to constrain the possible ways in which diamond can form in the mantle.

Experimental studies over the past several decades by research groups worldwide have shed light on aspects of natural diamond formation. Such studies may be divided into four types: (1) fluid- or melt-assisted recrystallization of graphite, (2) oxidation of reduced C-bearing fluids, (3) reduction of oxidized C-bearing fluids, and (4) reduction of carbonate. Of these, (1) has been the most studied, (2) has not been addressed experimentally to date, and there are a few studies of type (3) or (4); an overview of these studies will be presented. In virtually all cases, diamond has nucleated and grown only at temperatures well above those at which natural diamond form.

The variety of types of experiments results from a lack of consensus about the nature of the fluid (or melt) involved in diamond formation. Even the source of the carbon that forms diamond is problematic: is it pre-existing graphite, a C-bearing fluid or melt, or carbonate?

In a contribution to type (1) studies, based on recent reports of halides in diamond inclusions and in kimberlite, we found that KCl has a catalytic effect on recrystallization of graphite at 1200°C in C-O-H fluids, producing diamond under conditions that preserved graphite in the halide-free fluid. In a type (4) study, we have demonstrated that a  $Fe_{70}S_{28}O_2$  melt can reduce magnesite in the presence of orthopyroxene at 1300°C at 6 and 7.5 GPa, although graphite forms rather than diamond [1]. When we tried analogous experiments with FeS-NiS liquids, we found they do not have the same effect, but coexist with magnesite.

Despite the successes to date of experimental studies, the challenge remains to nucleate and grow diamond at <1200°C.

## References

[1] Gunn S.C. and Luth R.W. (2006) *Amer. Mineral.* (in press).