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Quartz pseudomorphs after coesite

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Abstract

Coesite has recently been described as a primary phase in a mantle-derived kyanite eclogite from the Roberts-Victor kimberlite, South Africa. An additional specimen from the same locality contains large polycrystalline aggregates of quartz, resembling the quartz rims on the coesite grains in the first specimen. The characteristic textures of these quartz pseudomorphs after coesite are described to aid in the identification of further specimens.

Introduction

Coesite was first synthesized and described by Coes (1953). The stability field and inversion kinetics of coesite were investigated by MacDonald (1956), Boyd and England (1960), and Bell and Boyd (1968). The first natural occurrence was reported by Chao *et al.*, (1960) from Meteor Crater, Arizona, where it occurs as extremely fine-grained intergrowths in shocked quartz. Since then there have been numerous reports of similar coesite from impact structures, and the presence of coesite is now generally accepted to be characteristic of impact-metamorphosed rocks. The pressure–temperature stability field of coesite precludes its occurrence in crustal rocks except at impact sites. Because of the rarity of SiO_2-rich compositions in the mantle and the rapid quenching required to preserve coesite, it has only recently been described as a primary phase in a mantle-derived igneous rock (Smyth and Hatton, 1977). These authors report the occurrence of coesite as a primary phase in a grospydite from the Roberts-Victor kimberlite, South Africa. The rock contains peraluminous omphacite, garnet ($Gr_{50}Py_{28}Al_{22}$), kyanite, sanidine, and single crystals of coesite, rimmed by polycrystalline quartz, up to 3 mm in greatest dimension. Since this discovery, I have been given a second sample of a grospydite nodule from the Roberts-Victor Mine by Dr. J. Barry Hawthorne of DeBeers Consolidated Mines, Ltd. The second sample contains polycrystalline aggregates of quartz up to five mm in greatest dimension, but no coesite. However, the composition of the major phases of the two samples are remarkably similar, and the texture of these quartz grains closely resembles that of the quartz rims on the coesite in the first specimen. Coesite may be a more common phase in mantle eclogites than previously supposed, and a brief description of the characteristic texture may aid in the future identification of quartz pseudomorphs after coesite.

Description

Boyd and England (1960) and Bell and Boyd (1968) have shown that the speed of the coesite–quartz transition is greatly increased by the presence of water and of shear stress. There is no evidence of significant shear stresses in these coesite and quartz grospydites, but small amounts of water may have been present along grain boundaries to act as a catalyst for the transition during and after the emplacement of the kimberlite. There are no hydrous phases in the rock, but water is a likely contaminant from the kimberlite magma as are the minor amounts of K detected along grain boundaries with the electron microprobe. Further, the coesite grains in sample SRV-1 are rimmed by polycrystalline quartz, and presumably the reaction, catalyzed by water, began at the grain boundary and proceeded to the center of the grain. Figure 1 is a crossed-polarizer photomicrograph of a coesite grain in sample SRV-1 showing the reaction to polycrystalline quartz around the rim and along an internal fracture.

The multiple nucleation of quartz at the coesite grain boundary produces a characteristic radiating texture in the quartz near the boundary. This radiating texture is illustrated in Figure 2, which shows a central coesite grain surrounded by a large poly-

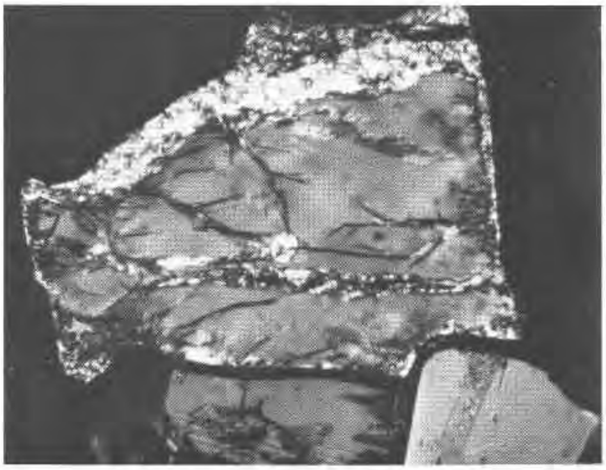

Fig. 1. Crossed-polarizer micrograph of a coesite grain about 3 mm across in sample SRV-1, showing polycrystalline quartz developed around the rim and along an internal fracture.

Fig. 2. Crossed-polarizer micrograph of a coesite grain about one mm across in sample SRV-1, showing radial growth of quartz from rim toward center.

crystalline aggregate of quartz. This texture can also be seen in Figures 3 and 4 from sample SRV-6, in which all the coesite has inverted to quartz. The interiors of the completely inverted grains appear to be randomly-oriented polycrystalline quartz. The radial growth of quartz is not always apparent as in Figure 1; however, it is quite distinctive when present, and appears in nearly all the quartz grains in sample SRV-6.

Both grospydite samples contain more than fifty percent of nearly opaque, milky-white peraluminous omphacite which, together with the blue kyanite and orange garnet, makes the rocks quite distinctive in hand specimen. The milky-white color of the pyroxene is caused by the exsolution of Al-rich pyroxene and quartz. The nature of these unusual pyroxenes and their breakdown is currently being investigated. It is hoped that this brief description of the textures of quartz pseudomorphs after coesite will aid in the identification of further specimens of coesite ecl-

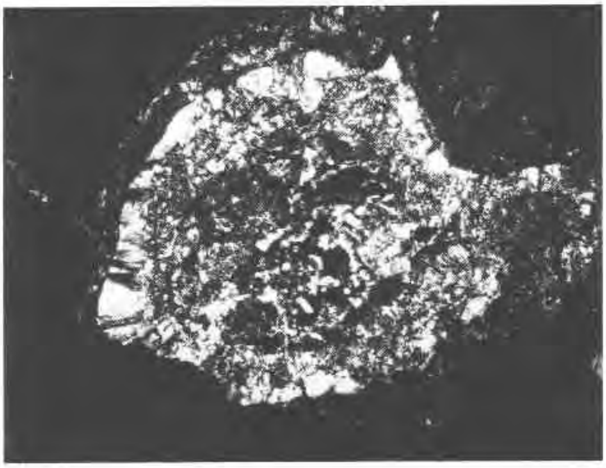

Fig. 3 and 4. Crossed-polarizer micrographs of polycrystalline aggregates of quartz in sample SRV-6, showing the characteristic radial growth texture around the rim. All of the coesite in this specimen has inverted to quartz. The approximate dimension across Figure 3 is 8 mm and Figure 4 is 5 mm.

ogites, so that the petrologic or tectonic processes giving rise to SiO_2-rich rocks in the earth's mantle can be better characterized.

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