SHORT COMMUNICATIONS

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Coesite from quartz-jadeitite in the Dabie Mountains, Eastern China

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THE Dabie Mountains is a collisional orogen between the North China and Yantze Continental plates. It is composed, from south to north, of the foreland fold and thrust belt alternated with molasse basin, the subducted cover and basement of the Yangtze continental plate, the meta-ophiolitic melange belt, the forearc meta-flysch nappe (bounded by southward and northward thrust belts) in which there may be a buried volcanic arc and a relict back-arc basin (Fig. 1A) (Xu *et al.*, 1992*a*, 1994). The well known ultra-high pressure metamorphic belt (UHPMB) is located in the area of the subducted basement and cover of the Yangtze continental plate and distributed over an area of more than 1000 km^2 in Anhui province. It is composed of blocks and mylonitic matrix, both of which are of eclogite facies. Rock types include eclogite, garnet-pyroxenite, garnet-peridotite, some other ultramafics, marble and quartz-jadeitite, and the matrix is mainly two-mica-plagioclase gneiss. The UHPMB is enveloped by the granite-gneiss, the underthrust basement, the peak metamorphism of which is of amphibolite facies (Fig. 1A). Coesite inclusions were reported from eclogite, garnet-pyroxenite (Okay *et al.*, 1989; Wang *et al.*, 1989) and even from gneiss and marble (Wang and Liou, 1991), especially in the cases where microdiamonds were recovered from eclogite in marble (Xu *et al.*, 1991; 1992*b*). What we report here is an occurrence of coesite inclusions in jadeite and garnet from quartz-jadeitite which is considered to be a metamorphosed greywacke (Su Wen *et al.*, 1995).

Geology and petrology of quartz-jadeitite

A large number of quartz-jadeitite blocks are found in the most easterly UHPMB in the Dabie Mountains. They were assigned to jadeitite or jadeite-quartzite (Xu *et al.*, 1991; 1994; Zhai *et al.*, 1992), but coesite inclusions were not recorded. Quartz-jadeitite occurs as tectonic lenses in a narrow belt trending E–W, convex to south, with length over 20 km and width *ca.* 1 km. The block described here covers an area 0.35 km^2 at the east end of the quartz-jadeitite belt near Miaozhu (Fig. 1B). Most the quartz-jadeitites are altered to jadeite-bearing gneiss, and are associated with blocks of eclogite and marble. Quartz-jadeitite is medium grained, light grey or blue coloured in hand-specimen. Ellipsoid jadeite grains with fresh jadeite in the core, surrounded by symplectites visible with the naked eye, show a massive texture at the centre and a gneissic structure towards the margin of the block. The occurrence of the foliation varies from place to place due to multiple deformation. All the tectonic blocks including quartz-jadeitite are enveloped by mylonite bands of eclogite facies alternated with weakly strained layers (Xu *et al.*, 1994).

The quartz-jadeitite is composed of jadeite, quartz, garnet, rutile, aegirine, zoisite, apatite (Fig. 2A) and a few amphibole, biotite, magnetite, titanite, epidote and chlorite grains, which are of three generations: (1) Cs + Jd + Gt + Q+ Ru + Zo + Ap; (2) Gt + Q+ Ti + Ab + Na-Amp + Epi + Aeg; and (3) Ab + Amp + Mt + Bi + Chl. A modal analysis of sample 924003

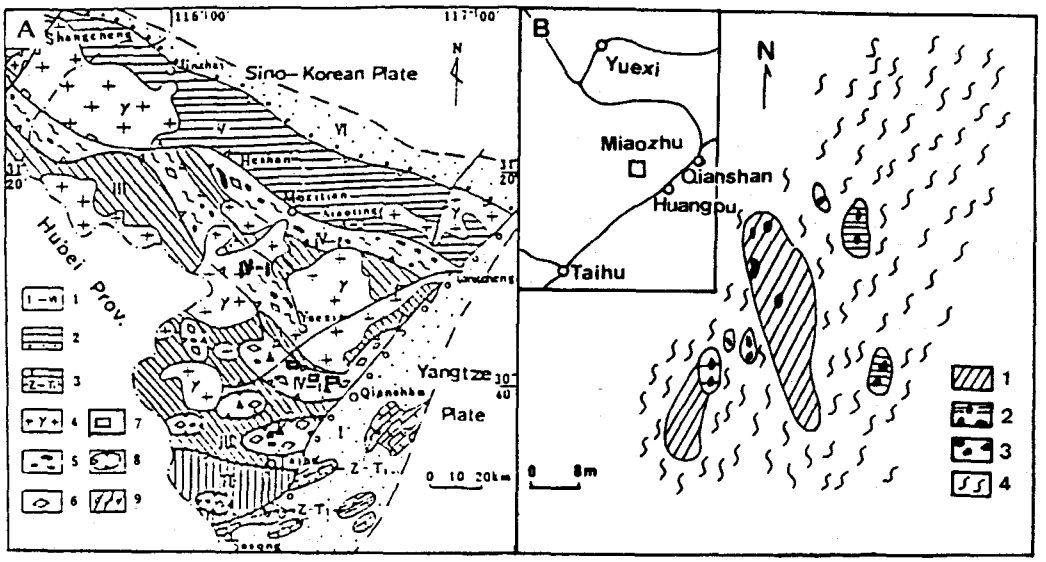

FIG 1. Geological sketch of the Dabie Mountains, Eastern China. (A) Tectonic map of the Dabie Mountains. 1, tectono-petrological units: I, foreland belt including folded and thrust unmetamorphosed rocks of Sinian to early Triassic, and Mesozoic molasse; II, underthrust cover of the Yangtze continental plate of greenschist facies; III, underthrust basement of the Yangtze continental plate of amphibolite facies; IV-1, eclogite belt over the area of underthrust basement of the Yangtze continental plate; IV-2, meta-ophiolite melange; V, forearc flysch nappe of greenschist facies; VI, Mesozoic successor basin. 2, terrestrial sediments of Middle Triassic to Tertiary; 3, unmetamorphosed cover of Sinian to early Triassic; 4, granite; 5, ultramafic rock block; 6, ultrahigh-pressure metamorphic rock block; 7, coesite-bearing quartz-jadeitite; 8, nappe; and 9, faults. (B) Geological sketch of the quartz-jadeitite blocks near Miaozhu. 1, quartz-jadeitite; 2, marble with eclogites; 3, eclogite; 4, two-mica-plagioclase gneiss.

yields: jadeite 55%; quartz 36%; garnet 5% (including altered products: amphibole, albite and epidote); rutile 0.5%; titanite 0.2% and ilmenite 0.3% (after rutile); zoisite 0.5%; and inclusions in both garnet and jadeite: rutile 1.0%, jadeite <0.1%; quartz 0.5%; coesite <0.1%; magnetite <0.1%; apatite 0.1% and zircon 0.1%. A symplectite around jadeite is composed of albite surrounded by a thin rim of aegirine (= 0.5%). Jadeite crystals are from 0.8 to 4.0 mm in size, and sometimes elongated in ribbon texture with the length:width ratio roughly 4:1; inclusions of rutile, apatite and rare coesite are found in jadeite. The end component of jadeite is calculated to be 84.20 to 89.60 mol.% and falls into the field of metagreywacke in the diagram of metamorphic clinopyroxenes (Okay, 1978). Two generations of quartz can be discerned. The first occurs as individual grains (0.5–3.0 mm in size) with ribbon texture and deformation lamellae and is inferred to be produced under high- to ultrahigh-pressure metamorphism by the reaction: albite = quartz + jadeite, or in other words, it is associated with the formation of jadeite. The second comprises the quartz pseudomorphs after coesite, with the occurrence of polycrystalline aggregates. Garnets are always euhedral (0.5–3.0 mm in size). The composition of the garnets, determined by microprobe, is: Sp 1.9, Pyr 12.8, Gr 15.8, Alm 69.5 mol.%. They are considerably richer in almandine than garnet from eclogites (Xu *et al.*, 1992). In the retrograded quartz-jadeitite sample (9010547-5), jadeites are partially or wholly pseudomorphed by fine-grained aggregates of albite bordered with a thin rim of green aegirine, and the garnets are always altered to symplectite composed of plagioclase and amphibole or epidote (and sometimes with biotite), with rutile altered to titanite or ilmenite.

The symplectites around relict jadeite crystals always comprise three zones. By examination of a thin-section (9010547-5 from the margin of the same outcrop of 924003), an original prismatic jadeite crystal with the short diameter 1120 μm, is composed of a relict jadeite with radius 120 μm, surrounded by a fine fibrous symplectite of albite of 360 μm across, and then a coarse-grained albite corona 60 μm wide, bordered by a thin rim (20 μm) of aegirine (Fig. 2B).

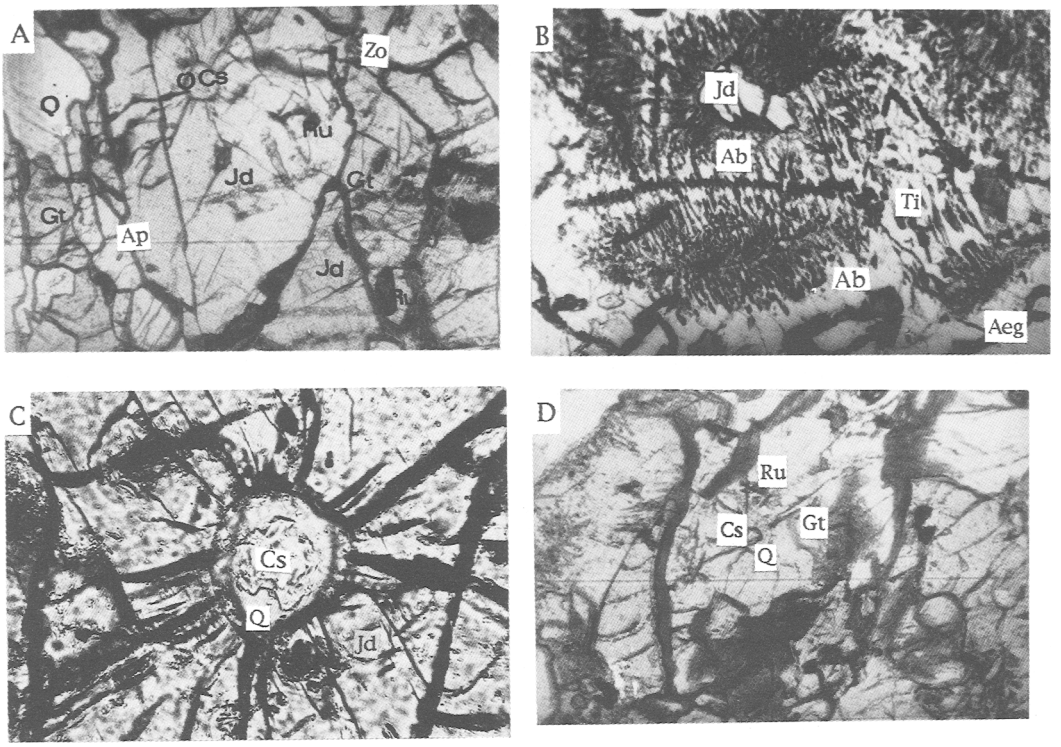

FIG. 2. Photomicrographs showing mineral parageneses. (A) Jadeite associated with quartz, garnet, rutile, zoisite and apatite in the quartz-jadeitite. Jd, jadeite; Q, quartz; Gt, garnet; Ru, rutile; Zo, zoisite; Ap, apatite, single nicol. Width of image is 0.88 mm. (B) Partially retrograded quartz-jadeitite showing symplectite around jadeite. Jd, jadeite; Ab, albite; Aeg, aegirine; Ti, titanite, crossed-nicol. Width of image is 0.80 mm. (C) A coesite (high relief) surrounded by polycrystalline quartz (lower relief) after coesite within a jadeite porphyroblast. Radial fractures are well developed in jadeite around the inclusion, from quartz-jadeitite in thin-section 924003, single nicol. The scale bar is 0.05 mm. (D) Coesite (high relief) surrounded by polycrystalline quartz (lower relief) after coesite within a garnet porphyroblast. Radial fractures are well developed in garnet around the inclusion; from quartz-jadeitite in thin-section 924003, single nicol. The scale bar is 0.05 mm.

No quartz has been found in either the fine-grained or coarse-grained zones; it is therefore reasonable (by the reaction jadeite + quartz = albite) to deduce that during a drop in temperature and pressure the albite is produced from the residual quartz which was originally formed by decomposition of albite under high–ultrahigh pressure. Thus, there should be no quartz in the symplectite produced by decomposition of jadeite. The aegirine occurred as a thin rim bordering the symplectite and is inferred to have been produced in the initial stage of retrogade metamorphism (depressure) by the reaction: jadeite = albite + aegirine $\pm$ paragonite.

The chemical composition of the quartz-jadeitite of sample 924023-3 (slightly altered) from the same outcrop of 924003, is SiO_2 73.19, Al_2O_3 12.35, TiO_2 0.59, Fe_2O_3 3.70, FeO 1.82, MnO 0.03, MgO 0.89, CaO 1.23, Na_2O 4.96, K_2O 0.09, P_2O_5 0.11 and falls in the greywacke field in the ACF and A′KF diagrams (Su Wen, *et al.*, 1995).

Coesite

Coesite, or its quartz pseudomorph, occurs as minute inclusions in both jadeite and garnet from the quartz-jadeitite. Two coesite inclusions in 924003 are measured 40 × 90 μm across (prismatic) surrounded by quartz pseudomorphs with a diameter (including coesite) of 60 × 100 μm and 45 × 45μm (rounded) with the rimmed quartz pseudomorph 100 × 100 μm (including coesite) across; some other inclusions, mainly rutile, are associated. Coesite in garnet is measured at 45 × 45μm with an ellipsoidal appearance in the centre surrounded by polycrystal-

line quartz 100 × 120 μm (including coesite). Coesite was recognized under the microscope by its high relief and the radial fractures in the host jadeite and garnet (Fig. 2C,D). The optical identification of coesite was confirmed by Raman spectra, characterized by a peak at 520 cm^{-1}.

As for the interstitial quartz associated with jadeite, it is inferred to be orginally coesite under ultrahigh-pressure metamorphism by the occurrence of coesite inciusions, and then retrograded to quartz after peak metamorphism, but there is no evidence for it here, though some interstitial coesite was found in eclogite in the Dabie Mountains (Banno, pers. comm.).

Conclusion

This note presents a new locality and a new rock type of coesite-bearing rocks in the UHPMB in the Dabie Mountains. The protolith may have been a greywacke before being metamorphosed into a coesite-jadeitite and then partially retrogressed to a quartz-jadeitite.

Acknowledgements

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