Mantle genesis of diamond in carbonate-silicate-carbon melts of variable chemistry: Evidence from high-pressure experiments

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Carbonate-silicate nature of mantle melts responsible for formation of natural diamonds is revealed by contemporary data of high-pressure experiment and chemical mineralogy. Highly compressed multicomponent carbonate-silicate melts are of high carbon solubility. But, the melts can be considered as parent diamond-forming media only if labile carbonate-silicate-carbon melt-solutions oversaturated to diamond are originated. Experiments on diamond spontaneous crystallization in multicomponent carbonate-silicate-carbon melts (compositionally similar to fluid-bearing multiphase primary inclusions of K_2O-Na_2O-CaO-FeO-MgO-Al_2O_3-TiO_2-P_2O_5-SiO_2-Cl-CO_2-H_2O chemistry in diamonds from Botswana [Schrauder, Navon, 1994]) showed that labile carbon oversaturations were run, and diamonds effectively formed [Litvin, Zharikov, 2000]. It is appropriate to recognize major (carbonate and silicate) and admixed (oxides, sulfides, phosphates, haloids, carbon dioxide, water, etc.) components in the compositions of natural parent media. Experiments show that silicate-carbonate-carbon melts with high silicate component contents (more than 60 wt.%) are not effective for diamond nucleation. By mineralogical data, essential composition variability of multicomponent carbonate-silicate parent media accompanying diamond formation evidently exists due to fractional crystallization of the melts. In the processes, contents of admixed components may increase to the levels comparable with the major component concentrations. Experiments on diamond spontaneous crystallization were realized in the labile Fe-Ni-Cu-S-sulfide – carbon [Litvin, et al., 2002], KCl-chloride – carbon [Litvin, 2003] and H_2O – carbon [Akaishi, Yamaoka, 2000] melt-solutions suggesting that local rise of admixed sulfide, chloride and water concentrations in the parent carbonate-silicate-carbon melts is perfectly combined with crystal growth of natural diamonds. Support: RFBR grant 02-05-64684.

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UHP mineral inclusions hidden in zircons from amphibolites in Sulu terrane, eastern China

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The amphibolites occur sporadically as thin layers and blocks throughout the Sulu terrane, eastern China. All analyzed amphibolite outcrop and core samples from pre-pilot drillhole CCSD-PP1 and CCSD-PP2, Chinese Continental Scientific Drilling Project in the Sulu terrane, are retrograded eclogites overprinted by amphibolite-facies retrograde metamorphism, with characteristic mineral assemblages of amphibole + plagioclase + epidote ± quartz ± biotite ± ilmenite ± titanite. However, coesite and coesite-bearing ultrahigh-pressure (UHP) mineral assemblages are identified by Raman spectroscopy and electron microprobe analysis as inclusions in zircons separated from these amphibolites. In general, coesite and other UHP mineral inclusions are preserved in the cores and mantles of zircons, whereas quartz inclusions occur in the rims of the same zircons. The UHP mineral assemblages consist mainly of coesite + garnet + omphacite + rutile, coesite + garnet + omphacite, coesite + garnet + omphacite + phengite + rutile + apatite, coesite + omphacite + rutile and coesite + magnesite. Garnet inclusions in zircon separates from amphibolites, are characterized by low MnO content (0.25 wt %-0.57 wt %), with molecular percentages, Alm = 50.4-54.1, Prp = 22.9-26.1, Grs = 21.2-22.5 and Sps = 0.6-1.2. All omphacite inclusions show compositional ranges of $Jd_{45.1\text{-}49.6}$ $Aeg_{4.1\text{-}8.8}$ $Aug_{44.4\text{-}48.6}$. All phengite inclusions, adjacent to coesite, garnet and omphacite inclusions in zircon domains, have Si values ranging from 3.46 to 3.48 p.f.u. (O=11). Analyzed magnesite inclusions, coexisting with coesite inclusion in the same zircon domain, contain about 31.21 wt % - 32.47 wt % MgO and 17.47 wt % - 18.10 wt % FeO, and about 0.73 wt % - 0.81 wt % CaO. They have X_{Mg} (Mg/(Mg + Fe + Ca)) = 0.75-0.76, X_{Fe} (Fe/(Mg + Fe + Ca)) = 0.23-0.24, and X_{Ca} (Ca/(Mg + Fe + Ca)) = 0.01. Rutiles together with coesite, garnet and omphacite occur as inclusions in the cores of zircons from amphibolites. The TiO_2 content of analyzed rutile inclusions ranges from 97.48 wt % to 99.31 wt %, with FeO content ranging from 0.43 wt % to 0.47 wt %. Compositions of analyzed mineral inclusions mentioned above are very similar to those of matrix minerals from Sulu eclogites. These UHP mineral inclusion assemblages yield temperatures of 631-780°C and pressures of ≥28 kbar, representing the P-T conditions of peak metamorphism of these rocks, which are consistent with those (T=642-726°C, P≥28 kbar) deduced from adjacent eclogites. These data indicate that the amphibolites are the retrogressive products of UHP eclogites.