NEW THINKING SPARKLED IN DEEP-SUBDUCTION OF CONTINENTAL CRUST

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Since discovery of coesite and diamond in regional ultrahigh-pressure (UHP) metamorphic eclogites and gneisses, it has been well evidenced that slivers of continental crust with low density could be subducted deeply to mantle depth of about 120 km (Cong and Wang, 1999). How deep can continental lithosphere subduct during continent-continent collision? This is one of the interesting and controvertible questions studied in the field of UHP metamorphism. $FeTiO_3$ rods of micrometer-scale were found in olivine of the UHP lherzolite in Alpe Arami and interpreted as exsolution of perovskite at pressure of 10—15 GPa (corresponds to the depth of 300—400 km) from olivine rich in TiO_2 (about 0.7 wt%) (Dobrzhinestskaya, L., Green, H. W., and Wang, S., 1996). Theoretically, the olivine should be transformed to denser wadsleyite or ringwoodite structure at the pressure of 10—15 GPa. Therefore, the Alpe Arami lherzolite was considered as a kind of the mantle transition zone. Ye Kai et al. (1997, 2000) and Zhang and Liou (1999) describe high concentration of clinopyroxene, rutile and apatite exsolutions in garnet of eclogite occurring in Dabieshan-Sulu ultrahigh pressure metamorphic belt. The K-feldspar lamellae have also been found in clinopyroxene of eclogite by Ye Kai (Fig. 1, personal communication). Clinoenstatite exsolutions in diopsite were further reported from UHP lherzolite of Alpe Arami, and from garnet-pyroxenite of Donghai, north Jiangsu, China (Ernst, W. G., Liou, J. G., Green, H. W., et al., 1998). Although the mechanisms of exsolution of some mineral phases in the ultrahigh pressure minerals are poorly known, the above-mentioned discoveries have been considered to result from exsolution of very high pressure precursor phases at mantle depth by most researchers. Now geoscientists are trying to find whether or not continental lithosphere, like oceanic lithosphere, could be dragged down to depth of 670—720 km.

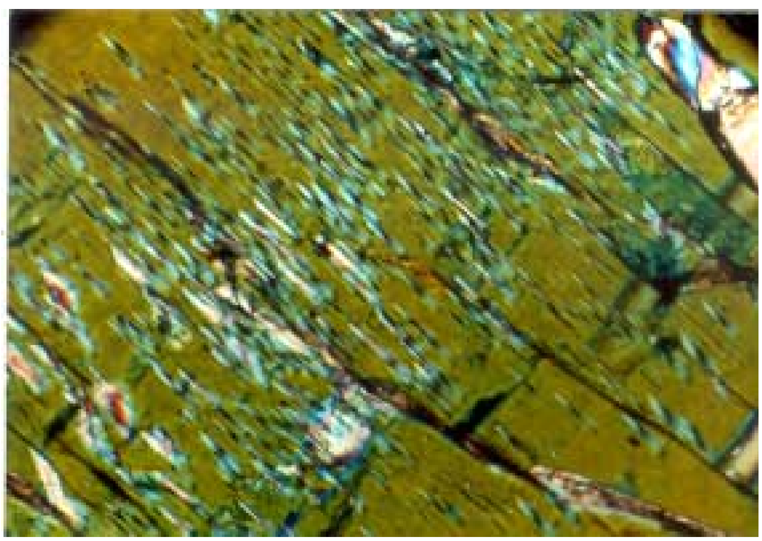

Fig. 1 K-feldspar lamellae in clinopyroxene of garnet peridotite in Zhimafang of North Jiangsu Province (after Ye Kai)

We have to think some questions if continent can be subducted to mantle depths (See Fig. 2). An interesting question is how a continental lithosphere changed itself physically and chemically during subduction down to the depth of hundreds of kilometers. What kind of interaction could happen between the subducting continental lithosphere and the upper mantle? Could atmosphere fluids (H_2O and CO_2) contained in sedimentary rocks deposited on surface be brought into the upper mantle?

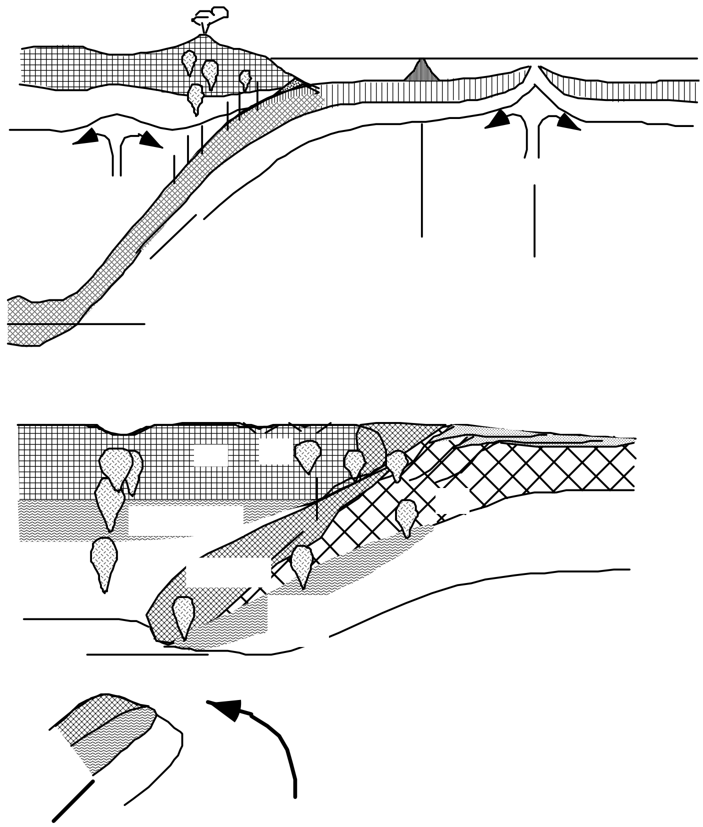

Fig. 2 Diagram showing deep subduction of oceanic and continental lithosphere

(a) Cold and heavy oceanic lithosphere subduct down to a depth of 670 km and form megalith? During subduction, oceanic crust (OC) and sediments would experience greenschist (GS), blueschist (BS) to eclogite (E) facies metamorphisms. Some fluids (H_2O, CO_2) would be released and others brought to mantle. Volcanic arc and backarc basin might form above the mantle wedge. Mantle plume under the oceanic lithosphere might result in middle ocean ridge and oceanic island.

(b) Continental lithosphere might also subduct deeply beneath another continental lithosphere. During subduction, the materials of continental crust (CC) would experience a process from high-pressure (HP) to ultrahigh-pressure (UHP) metamorphism. Some fluids will be released and others brought to mantle. The continental lithosphere with low density might be broken off when it subducted to a certain depth. The lower section would sink into mantle, while the upper section would exhume. The mantle upwelling through the break point would melt partially the subducted crustal materials and result in syn-collision magmatism (SM).

The UHP rocks were exhumed to surface shortly after their deep subduction. Such a geodynamic process of great scale has introduced much new thinking. How deep could continental crust be subducted during continent-continent collision? What kind of physical and chemical changes would these deeply-subducted continental materials experience? Could these subducted “dry” continental crust slivers react with mantle material? Has any fluid from shallow crust been brought down to upper mantle? How could UHP rocks exhume from mantle depths to surface? Paradox remains in answering most of these questions. Any progress in approaching them will bring a mighty advance in understanding the planet where we live on.

The international enthusiasm in studying ultra-high-pressure metamorphism and deep subduction has sustained for a decade. A project “Processes and Geodynamics in Formation and Exhumation of the Ultrahigh-pressure Metamorphic Terrains” led by Chinese scientists has been listed as International Lithosphere Project III-8. The National Natural Science Foundation of China established a grant to support the study of UHP metamorphism and orogenic belts in the years 1997-2001. Recently, a national project “ Continen deep-subduction” has been approved for the next 5 years by China Government. Every important progress in the study of continental deep subduction will influence and even change the prevalent geodynamics, as well as many branches in geoscience.

The study of continent deep subduction will have important influence not only for geoscience, but also for some other fields. One of the examples is to determine the composition and structure of those tiny UHP minerals at μm scale, which asks to develop precise *in-situ* analysis methods. To analogue the role of fluids in phase change and reactions under UHP condition needs to develop high-PT techniques in laboratory. These high technical developments no doubt will impact the materials sciences.

Could a new revolution in solid geosciences be inspired by the extensive study of continent deep-subduction?

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