Thermal evolution of lithosphere-asthenosphere boundary; direct observation from the Lanzo massif, western Alps, Italy

*青木 智[1]、小澤 一仁[1]、Bodinier Jean-Louis[2]、Boudier Françoise[2]
*Tomo Aoki[1], Kazuhito Ozawa[1], Jean-Louis Bodinier[2], Françoise Boudier[2]

1. 東京大学、2. モンペリエ第二大学
1. The University of Tokyo, 2. Montpellier 2 University

The lithosphere-asthenosphere boundary (LAB) is fundamental in plate tectonics, but its definition is diverse, and defining mechanisms are still controversial (McKenzie and Priestley, 2005; Rychert and Shearer, 2009; Fischer et al., 2010; Karato, 2012). The seismically defined LAB transition has various sharpness (<10km - <30km) depending on regions (oceanic vs. continental) as well as observational methods. We call this transitional region as LAB zone, the internal structure and dynamic behavior of which are far from well understood. We studied a large and continuous exposure of mantle materials possibly representing the shallow LAB zone to address this issue. The Lanzo peridotite massif, the exposure area of which is 20 km x 10 km and suited for our purpose, is located in western Alps and was exhumed by Alpine orogeny in the early Mesozoic (~200Ma). The massif consists dominantly of fertile plagioclase-bearing peridotites, which is stable at pressure lower than ~1GPa, with lesser amount of less fertile spinel peridotites. It is divided into three bodies, north, central and south, which are separated by shear zones (Boudier, 1988). Chemical and microstructural heterogeneities on various scales have been reported from the massif (Bodinier, 1988; Bodinier et al., 1991; Kaczmarek and Müntner, 2006). Bodinier et al. (1991) proposed, on the basis of geochemical studies of the massif, that the southern body was originated from asthenosphere and the northern part was sub-continental lithosphere. If this is the case, the complex provides excellent opportunity for direct observation of the LAB zone, from which we may scrutinize dynamic processes operating there. The model must be assessed in the viewpoint of thermal structure and its temporal change in the Lanzo massif. Bodinier et al. (1986) estimated "equilibration conditions" as ~0.5GPa and 900-1250°C for a plagioclase lherzolite sample, but this must be reappraised in the framework of thermal history. We examined both plagioclase peridotites and mafic rocks collected from six localities: 1 from the north, 2 from the northern shear zone, 2 from the central, and 1 from the south bodies. Petrographic observations of thin sections with a polarized optical microscope and mineral chemical analyses with an electron probe micro-analyzer (EPMA) were conducted at the University of Tokyo. We confirmed that there are systematic variations of microstructures and mineral chemical compositions representing fertility of peridotites in the massif, which is principally consistent with previous studies (Boudier and Nicolas, 1988; Bodinier, 1988; Bodinier et al., 1991). We examined variations of "frozen temperature and pressure" conditions within the massif based on mafic and ultramafic rocks from the selected localities. The "frozen temperatures" were estimated by CaO solubility in olivine and pyroxenes as well as Mg-Fe partitioning between olivine and spinel, all of which tend to decreases from the south to the north bodies for the both lithologies. The "frozen pressure" variation was also estimated by Ca/(Ca+Na) in plagioclase with consideration on the fertility of peridotites. It has a tendency of decreasing from the south to the north bodies. We also examined chemical heterogeneities of pyroxenes, plagioclase, and spinel grains, which suggest continuous cooling and decompression as suggested by Bodinier et al. (1986). Though we still cannot specify when the identified thermal structure was frozen in the minerals, it must have been established before the exhumation of the massif because all the temperature-sensitive mineral chemical parameters consistently indicate the same tendency. We conclude that tens of kilometers scale of thermal structures of the LAB zone were frozen in addition to chemical structures in the Lanzo massif during its exhumation.

キーワード：リソスフェアーアセノスフェア境界、マントルかんらん岩、熱構造
Keywords: lithosphere-asthenosphere boudary, mantle peridotite, thermal structure