Geophysical Research Abstracts, Vol. 7, 00616, 2005
SRef-ID: 1607-7962/gra/EGU05-A-00616

Dissakisite-(La), a new end-member of the epidote group from the Ulten peridotites (Italian Eastern Alps): Evidence of mantle-crust interactions in subduction zones.

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Dissakisite-(La), ideally $CaLaAl_2MgSi_3O_{12}(OH)$, has been found in the Hochwart peridotite, Ulten zone, Italy. The mineral appears as cm-sized black to very dark brown anhedral nodules and smaller grains. Associated minerals are: olivine, spinel, amphiboles, clino- and orthopyroxenes, and minor clinochlore, uraninite, thorite, thorianite, phlogopite, zircon, apatite, calcite, dolomite, pentlandite and copper sulfides. The dissakisite-(La) occurs in a fine-grained spinel–amphibole-bearing peridotite with minor clinopyroxene. The spinel–amphibole-bearing paragenesis is interpreted to have developed after the eclogite-facies peak of subduction metamorphism at lower-P, but higher P_{H2O} (amphibolite/greenschist facies). Amphibole and chlorite, which occur as parallel lamellae in dissakisite, probably developed by exsolution during retrogression, although an epitactic growth is not totally excluded. This suggests that dissakisite-(La) crystallized either at the eclogite-facies stage, or during the early stage of retrogression. Crystallization under eclogite-facies conditions would be compatible with the experimentally determined stability field of allanite in the system KCMASH (up to 1150°C and 4.5 GPa; Hermann 2002), and with the estimated metamorphic conditions for dissakisite-(Ce) from the Su-Lu terrane ($T \geq 760$°C and P $\geq$ 4.2 GPa; Yang and Jahn 2000).

The first finding of dissakisite in peridotite concerned a 0.22-mm sized relic of chromian dissakisite-(Ce) included in a clinopyroxene of the garnet-bearing peridotite of Zhimafang, Su-Lu ultra-high-pressure metamorphic terrane, eastern China (Yang and Enami 2003). Formation of dissakisite-(Ce) is believed to have predated recrystal-

lization of the host peridotite, which occurred at 760˚C and 4.2 GPa (Yang and Jahn 2000). The dissakisite-(La) from the Ulten zone reported in the present study occurs as up to cm-sized crystals in the olivine matrix of a retrogressed spinel–amphibole peridotite. Based on petrographic evidence and thermobarometric estimates, the Ulten dissakisite-(La) formed at P $\leq$ 2.7 GPa and T $\leq$ 850˚C. In both Su-Lu and Ulten examples, the dissakisite-bearing peridotites are hosted by high-pressure gneisses (cf. for Ulten, e.g. Godard et al. 1996; for Su-Lu, e.g. Medaris 1999). A high- or ultra-high-pressure genesis of peridotite-hosted dissakisite is compatible with the recent experimental results of Hermann (2002), who found a negative-slope for the allanite-in/zoisite-out curve starting at T = 850˚C and P = 2.0 GPa, and ending at T = 710˚C and P = 3.5 GPa. In fact, as the author worked in a REE-doped KCMASH system, his "allanite" is actually dissakisite.

Whereas Su-Lu peridotite-bearing gneisses do not display evidence of partial melting (Yang, pers. comm.), migmatization is widespread in the Ulten gneisses (Godard et al. 1996; Martin et al. 1998; Del Moro et al. 1999). Such process is believed to have played an important role in the LILE (i.e. LREE, Sr, Ba, Rb) metasomatism of the entrained peridotites (Rampone and Morten 2001; Tumiati et al. 2003). Hauzenberger et al. (1996) proposed that migmatization of the Ulten gneisses occurred by prograde, fluid-saturated, partial melting. The general absence of white mica and abundance of garnet + kyanite in the restitic assemblages suggest that the gneisses passed through a muscovite (phengite)-dehydration melting reaction along either a prograde or decompressional path (Tumiati et al. 2003). During crystallization of the melt, a water-rich fluid phase was released, as testified by H_2O-rich fluid inclusions in the quartz of the leucosomes of the migmatitic gneisses (Höller and Hoinkes 1996). According to Rampone and Morten (2001), reactions between the peridotites and a LILE-enriched, High-Field-Strength Elements (HFSE)-depleted metasomatizing fluid with a low CO_2/H_2O ratio were responsible for the LREE and Sr enrichment in clinopyroxene, and the crystallization of abundant LILE-rich, HFSE-poor, pargasitic amphibole. Using isotopic data, Tumiati et al. (2003) found the same Sm-Nd ages for the migmatization and the HP metamorphism of Ulten gneisses. They also provided evidence for the concurrent introduction of crustal Nd in the amphibole-bearing garnet peridotites, thus supporting the strict link between gneiss migmatization and peridotite metasomatism.

Data on partitioning of REE between allanite and aqueous fluid indicate strongly compatible behavior of LREE, but a relatively flat LREE pattern (Banks et al. 1994; Frei et al. 2004). In particular, Banks et al. found similar values of $D_{La}^{aln/fluid}$and $D_{Ce}^{aln/fluid}$. Therefore the high La/(La + Ce) ratio of our dissakisite-(La) would require crystallization from a fluid characterized by La $>$ Ce. Such a fluid could be the result of several processes, such as: (i) fractionation of garnet with Ce $>$ La in the restite during migmatization; (ii) La/Ce fractionation during fluid release from the melt (cf. Flynn and Burnham 1978); (iii) La/Ce fractionation during amphibole formation in the peridotite.

The time of 330 Ma is representative for the HP-metamorphism and the essentially coeval migmatisation in the northeastern Ulten zone (Tumiati *et al.*, 2003). Accordingly, the age of the dissakisite formation should also be around 330 Ma. If recalculated for t = 330 Ma, the positive ε_{Nd}(t) value of +1.7, which indicates a depletion in non-radiogenic neodymium, indicates a clear mantle-like imprint in the isotopic character of dissakisite which was evidently inherited from the host peridotite, like the enrichment in Cr and Ni. As a general feature, dissakisite-(La) is rich in trace elements ($e.g.$ La$_N$ $>10^5$). Chondrite-normalized REE concentrations show a regular decrease from La to Lu, interrupted by an Er–Tm peak. By the way, the strong enrichment in *LILE* and *LREE* with respect to the chondrite is typically showed by crustal minerals. Dissakisite-(La) shows a trace element pattern which point out a possible mixed upper–lower crustal source for the metasomatizing fluids. As a conclusion the mineral is regarded be formed in a mixed crust-mantle geochemical environment.

Dissakisite in subduction-zone peridotite is macroscopic evidence for metasomatism in a crustal subduction “mélange”. The rare findings of this mineral, however, suggest that its occurrence be restricted to those areas where the chemical exchange among peridotite rocks and melt-derived *LILE*-enriched crustal fluids have been strongly active.

References:

Banks, D.A., Yardley, B.W.D., Campbell, A.R., and Jarvis, K.E. (1994) REE composition of an aqueous magmatic fluid: A fluid inclusion study from the Capitan Pluton, New Mexico, U.S.A. Chemical Geology, 113, 259-272.

Del Moro, A., Martin, S., and Prosser, G. (1999) Migmatites of the Ulten zone (NE Italy), record of melt transfer in deep crust. Journal of Petrology, 40-12, 1803-1826.

Flynn, R.T. and Burnham, C.W. (1978) An experimental determination of rare earth partition coefficients between a chloride containing vapor phase and silicate melts. Geochimica et Cosmochimica Acta, 42, 685-701.

Frei, D., Liebscher, A., Franz, G., and Dulski, P. (2004) Trace element geochemistry of epidote minerals. Reviews in Mineralogy & Geochemistry, 56, 553–605.

Godard, G., Martin, S., Prosser, G., Kienast, J.R., and Morten, L. (1996) Variscan migmatites, eclogites and garnet-peridotites of the Ulten zone, Eastern Austroalpine system. Tectonophysics, 259, 313-341.

Hermann, J. (2002) Allanite; thorium and light rare earth element carrier in subducted crust. Chemical Geology, 192, 289–306.

Höller, W. and Hoinkes, G. (1996) Fluid evolution during high-pressure partial melting in the austroalpine Ulten zone, northern Italy. Mineralogy and Petrology, 58, 131-144.

Martin, S., Godard, G., Prosser, G., Schiavo, A., Bernoulli, D., and Ranalli, G. (1998) Evolution of the deep crust at the junction Austoalpine/Southalpine: the Tonale nappe. Memorie di Scienze Geologiche dell'Università di Padova, 50, 3–50.

Medaris, L.G. (1999) Garnet peridotites in Eurasian high-pressure and ultrahigh-pressure terranes: a diversity of origins and thermal histories. International Geology Review, 41, 799-815.

Rampone, E. and Morten, L. (2001) Records of crustal metasomatism in the garnet peridotites of the Ulten Zone (Upper Austroalpine, Eastern Alps). Journal of Petrology, 42, 207–219.

Rampone, E. and Morten, L. (2001) Records of crustal metasomatism in the garnet peridotites of the Ulten Zone (Upper Austroalpine, Eastern Alps). Journal of Petrology, 42, 207–219.

Tumiati, S., Thöni, M., Nimis, P., Martin, S., and Mair, V. (2003) Mantle-crust interactions during Variscan subduction in the Eastern Alps (Nonsberg-Ulten Zone): geochronology and new petrological constraints. Earth and Planetary Science Letters, 210, 509–526.

Yang, J.J. and Enami, M. (2003) Chromian dissakisite-(Ce) in a garnet lherzolite from the Chinese Su-Lu UHP metamorphic terrane: Implications for Cr incorporation in epidote-group minerals and recycling of REE into the Earth's mantle. American Mineralogist, 88, 604–610.

Yang, J.J. and Jahn, B.M. (2000) Deep subduction of mantle-derived garnet lherzolites from the Su-Lu UHP metamorphic terrane in China. Journal of Metamorphic Geology, 18, 167–180.