**Abstract.** — We review three case studies emphasizing the role of ultramafic rocks in the recycling of volatiles and trace elements at convergent plate margins. Serpentinites are major water carriers in subduction zones and their breakdown liberates large quantities of water at sub-arc depths. The incompatible elements incorporated during oceanic serpentinitization are released into the fluid phase produced once antigorite dehydrates to olivine + orthopyroxene. Importantly, the antigorite breakdown can trigger either wet melting or production of supercritical fluids in altered basalts and sediments. The produced fluid phases incorporate substantial amounts of incompatible element, initially residing in the crustal reservoirs. The fluid phase which exits the slab is highly reactive with respect to the overlying, silica undersaturated, mantle rocks. This leads to formation of reactive (ortho)pyroxenite layers, which filter the uprising hydrous melt/supercritical fluid to produce aqueous, incompatible trace element-rich residual fluids. This fluid has equilibrated with peridotites and is mobile in the mantle.

A consequence of these subduction fluid/mantle reactions is that the mantle wedge domains overlying the slabs can be heterogeneous in composition and layered, due to the presence of reactive pyroxenite bodies. Another aspect regards the debate whether supercritical fluids or hydrous melts are effective media for trace element transport. Since both agents are saturated in silica, they will react with the silica-undersaturated mantle wedge peridotites to produce aqueous, incompatible trace element-rich residual fluids. Hence, while hydrous melt and/or supercritical fluids are important for scavenging incompatible elements from the slab, they may not be the agents that transfer the metasomatic subduction signature to the inner parts of the mantle wedges.

**Riassunto.** — Questo contributo riassume tre casi di studio che evidenziano il ruolo delle rocce ultrafemiche nei processi di riciclo delle sostanze volatili e degli elementi in traccia ai margini di placca convergenti. Le serpentiniti sono i sistemi maggiormente responsabili per il trasporto dell’acqua nelle zone di subduzione, dove liberano grandi quantità di acqua a profondità di sub-arco a causa della disidratazione del serpentino. Gli elementi incompatibili incorporati da queste rocce durante l’alterazione oceanica, vengono rilasciati nel fluido prodotto dalla disidratazione del serpentino. L’acqua rilasciata dall’antigorite può innescare la fusione parziale o la formazione di fluidi supercritici nei livelli di rocce basaltiche e meta-sedimentarie costituenti la placca subdotta. I fusi o i fluidi così prodotti incorporano quantità significative di elementi maggiori (oltre il 50 % in peso) e in traccia...
originariamente presenti nelle rocce crostali. La fase fluida rilasciata dallo slab subdotto è altamente reattiva rispetto alle soprastanti rocce di mantello e causa la formazione di livelli reattivi a ortopiroxeno. Questi livelli ‘filtrano’ i fluidi supercritici e/o i fusi idrati uscenti dallo slab per produrre un fluido acquoso residuale ricco in soluto: quest’ultimo si è equilibrato con le peridotiti di mantello ed è in grado di migrare all’interno del wedge di mantello. Una conseguenza di queste reazioni fluido/mantello è che i dominii del cuneo di mantello soprastanti lo slab sono composizionalmente eterogenei e ‘stratificati’ a causa della presenza dei livelli di piroseniti reattivi. Un altro aspetto di queste ricerche riguarda l’efficienza dei fluidi supercritici o dei fusi idrati come agenti di trasporto degli elementi in traccia nel mantello. Entrambi gli agenti sono ricchi in silice e la loro reazione con il mantello libera fluidi acquosi mobili arricchiti in elementi incompatibili. Di conseguenza, mentre i fusi idrati e i fluidi supercritici sono importanti per incorporare elementi dai serbatoi crostali nello slab, essi non sono gli agenti che trasferiscono alle parti interne del cuneo di mantello l’impronta metasomatica subduttiva.

INTRODUCTION

Subduction zone fluids play a fundamental role in large-scale mass transfer at convergent plate margins, as they transfer volatiles and incompatible elements from crustal reservoirs in the subducting plates to the overlying mantle. The fluid transport leads to metasomatism of the mantle wedge peridotites and triggers partial melting in regions where peridotites are above the wet solidus temperatures. Based on detailed geochemical studies of arc lavas, it has been inferred that subduction fluids are enriched in large ion lithophile (LILE) and light rare earths (LREE) relative to the high field strength elements (HFSE; McCulloch and Gamble, 1991; Brenan et al., 1994). The crust-to-mantle exchange at subduction zones thus impacts on mantle re-fertilization and is a major driving force for the chemical differentiation of the Earth. The role of fluids in such a cycle has been increasingly emphasized in the last decade and an ongoing debate concerns their nature, composition and effective mobility (Scambelluri and Philippot, 2001; Manning, 2004; Hermann et al., 2006; Zack and John, 2007). The clear distinction between aqueous fluids and hydrous silicate melts, which characterizes all rock systems at relatively low pressures and temperatures, vanishes at ultrahigh-pressure conditions, where complete miscibility between water and silicate melts has been experimentally attained in a range of P-T conditions and of bulk rock compositions (Bureau and Keppler, 1999; Stalder et al., 2001; Schmidt et al., 2004; Hermann et al., 2006; Kessel et al., 2005). The existence of a second critical end point, where the wet solidus terminates and a supercritical liquid forms, opened the debate on the role of supercritical fluid phases as metasomatic agents in deep subduction environments.

Studies of natural eclogite-facies rocks provide important constraints to the understanding of deep subduction fluids and their interaction with slab and mantle wedge rocks. The high (HP) and ultrahigh-pressure (UHP) rocks exposed in orogenic terrains provide independent constraints on deep metamorphism in slabs, and represent exceptional natural laboratories on subduction-zone processes in a depth window between 50 and 200 kilometers. Some ultradepth coesite- and diamond-bearing rocks preserve primary solid multiphase inclusions (Van Roermund et al., 2002; Stoeckert et al., 2001; Ferrando et al., 2005; Malaspina et al., 2006; Scambelluri et al., 2007), which have been interpreted in some case as remnants of a supercritical fluid phase.

Ultramafic rocks play a fundamental role in volatile and element recycling at convergent plate margins. Field studies have shown that serpentinite is stable at eclogite-facies conditions and hence can transport water into the mantle (Scambelluri et al., 1995). Experiments demonstrate the prolonged stability of antigorite serpentinite to 200 km depth and identify hydrous ultramafic systems as exceptional water carriers into the Earth’s mantle (Ulmer and Trommsdorff, 1995; Wunder and Schreyer, 1997; Bromiley and Pawley, 2003). These findings have important consequences on subduction dynamics because serpentinites provide a particularly fertile water reservoir for arc magmatism (Ulmer and Trommsdorff, 1995), and because their dehydration can generate intermediate-depth (50-200 Km) earthquakes (Peacock, 2001; Dobson et al., 2002). Serpentinites also act as low density and low viscosity media enabling the exhumation of high and ultrahigh pressure rocks (Hermann et al.,
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2000; Guillot et al., 2001; Rupke et al., 2004). The mantle domains overlying the subducting plates are other environments where ultramafic rocks play a key role, as the fluid/peridotite interactions at the slab/mantle interface can control the composition of fluids, which are transferred to the inner parts of the mantle wedges. However, the understanding of mechanisms ruling the slab-to-mantle element transfer is essentially hampered by the paucity of suitable rock samples recording such exchange reactions. Most studies of supra-subduction zone peridotites investigated either fore-arc xenoliths, or xenoliths sampled at relatively shallow mantle levels, well above arc-magma sources (Vidal et al., 1989; Maury et al., 1992; Laurora et al., 2001). Information on deep metasomatism of the mantle wedge can be gained by studies of HP and UHP terrains, where felsic rocks host metasomatized peridotites (Bruckner, 1998; Rampone and Morten, 2001; Paquin et al., 2004; Scambelluri et al., 2006; Liou et al., 2004). Such associations enable to study the element exchange between crustal and mantle rocks at pressures corresponding to the sub-arc depth of the subducted slab.

To address the role of ultramafic rocks in the fluid and element cycling in subduction zones, here we review three field-based studies concerning fluid release in the slab and possible fluid-rock interactions at a slab-mantle interface. In the first part of this paper we discuss the serpentinite dehydration reaction in the slab, and its possible consequences in terms of interaction of de-serpentinization fluids with sedimentary or granitic layers in the slab. In the second part we discuss the case of ultrahigh-pressure garnet orthopyroxenites as proxies for the reaction between mantle peridotites with percolating silicate-rich agents released from felsic and/or metasedimentary slab components.

**Fluid production in subducted ultramafic rocks**

Serpentinites are key lithologies in the overall water cycle at oceanic and subduction settings. Several models assume a stratified structure of the slabs (e.g. Poli and Schmidt, 2002), with a lower ultramafic layer, an overlying mafic crust and an uppermost sedimentary layer. This structure can be inherited from a previous oceanic lithosphere, as documented in present-day fast spreading ridges. In such settings, serpentinization of the oceanic mantle occurs at outer rises, where fractures in the bending plates enhance seawater infiltration at and deep mantle serpentinization (Ranero et al., 2003; Peacock, 2001). Alternatively, part of the layered slab architecture may be erased by tectonic erosion and/or subduction deformation, e.g. boudinage of competent slab layers like the oceanic crust. Also, the lithosphere at slow and ultraslow spreading ridges is not layered, but is characterized by the vast exposure of serpentinized oceanic mantle at the seafloor (Cannat et al., 1995; Dick et al., 2003). During subduction of this type of oceanic lithosphere, serpentinites may be at the top of the slab.

Despite the considerable progress in understanding hydrous phase relations in subducted serpentinites, little is yet known about their geochemical features, particularly about the trace element fingerprints of the fluids released. The only natural cases of analyzed fluids produced during partial to complete breakdown of antigorite at HP to UHP concern the Erro-Tobbio serpentinites (Western Alps) and the chlorite harzburgites from the Betic Cordillera (Southern Spain) (Scambelluri et al., 1997; 2001; 2004a; 2004b; Trommsdorff et al., 1998). The high-pressure serpentinite cycle passes through two dehydration steps (Fig. 1): a minor “brucite-out” reaction leading to the first appearance of metamorphic olivine + antigorite + fluid, and a major fluid release (antigorite-out) related to full antigorite dehydration to olivine + orthopyroxene + fluid. The first reaction is recorded by many Alpine and Betic HP serpentinites (e.g. Liguria: Cimmino et al., 1979; Scambelluri et al., 1995; Zermatt: Li et al., 2004; Monviso: Lombardo et al., 1978; Nevada Filabride: Trommsdorff et al., 1998; Puga et al., 1999). In all these settings the serpentinites are associated with eclogites (Messiga et al., 1995; Messiga et al. 1999; Puga et al., 1999) and display a stable assemblage of olivine + antigorite + Ti-clinohumite + diopside + chlorite, crystallized at 500-650 °C and 2-2.5 GPa. The “brucite-out” reaction (Fig. 1) causes a loss of about 2 wt% bulk water from the initial serpentinites. Best records of this aqueous fluid are primary fluid inclusions hosted by olivine,
diopside and Ti-clinohumite crystallized in veins in the Erro-Tobbio serpentinites (Fig. 2a, b). The inclusions generally display a salt daughter crystal (Fig. 2a), locally associated with ilmenite and magnetite: their salinity can be as high as 50 wt% NaCl$_{\text{equiv}}$ and the salt composition corresponds to a mixture of (Na, K)Cl and MgCl$_2$ (Scambelluri et al., 1997). Such a composition was taken as evidence for deep recycling of oceanic chlorine and alkalies in the fluid phase (Scambelluri et al., 1997). Lower (present-day) average salinity of 10 wt% NaCl equivalents pertain to primary fluid inclusions present in olivine and diopside in the Betic high-pressure serpentinites (Scambelluri et al., 2001a). The first dehydration fluids released during the serpentinite subduction cycle thus correspond to aqueous solutions which concentrate high amounts of highly incompatible halogen species. The high salinity of such inclusions may reflect changes in the composition of pristine fluids driven by water-consuming processes, such as hydrous mineral crystallization in veins, or hydration of relict (dry) mantle minerals (Scambelluri et al., 1997).

The antigorite breakdown is the second and the most important dehydration reaction in subducted serpentinites (Fig. 1), leading to a bulk loss of 6.5-12 wt% water. This reaction is recorded by the metamorphic harzburgites of the Betic Cordillera, a unique rock type (Fig. 2c) showing spinifex textured olivine + orthopyroxene (Trommsdorff et al., 1998), as well as coarse granoblastic olivine, orthopyroxene, chlorite ± Ti-clinohumite. Such metamorphic harzburgites crystallized at 650-700 °C and 2 GPa (Trommsdorff et al., 1998; Puga et al., 1999; Lopez Sanchez-Vizcaino et al. 2005) (Fig. 1, Field 3); however, this assemblage can also form at UHP conditions (Ulmer and Trommsdorff, 1995). Olivine and orthopyroxene in these rocks contain primary fluid inclusions filled with solid daughter phases (olivine, magnetite-ilmenite, chlorite, apatite) and an interstitial aqueous liquid. These inclusions are remnants of the fluid phase released at the antigorite breakdown. An initial salinity range of 0.4 – 2 wt% NaCl$_{\text{equiv}}$ was estimated for this fluid from the bulk-rock net difference of water and chlorine between antigorite serpentinites and harzburgites (Scambelluri et al., 2004a). The trace element compositions of these inclusions were measured by Laser Ablation (LA) ICP MS, using the 0.4 – 2 wt% NaCl$_{\text{equiv}}$ estimates of the initial fluid salinity as internal standard (Scambelluri et al., 2004a, b). The spider diagram of Fig. 3 shows the trace element compositions of inclusions normalized to the primitive mantle. The fluid inclusions display appreciable incompatible element contents, the highest amounts pertaining to the light elements and the alkalies. In the inclusions, several elements (e.g. Boron) display large variations in the absolute concentrations, which may span over one order of magnitude. All fluid inclusions display comparable patterns, which are systematically enriched in LILE (Rb, Ba, Cs, Sr), B and Li with respect to the HFSE (Ti, Nb). These features are similar to what is observed in arc volcanics (Fig. 3) and are in excellent agreement with experimental results. Tenthorey and Hermann (2004) analyzed fluid compositions that were experimentally produced from the dehydration of serpentinites at high pressure. Their study showed that incompatible elements, which can be taken up during serpentinization, are fully released during the break down of antigorite.
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Interaction of fluids with subducted sediments

Depending on the structure of the subducting lithosphere, the serpentine breakdown fluids may either (i) directly infiltrate the mantle wedge, or (ii) react with crustal rocks of the subducted slab. The first case occurs if the slab is not layered (i.e. slab serpentinites are close to the interface with the mantle wedge) or if the fluid is channelled. This leads to a direct interaction of the antigorite-breakdown fluids with the mantle, which would acquire the signature shown in Fig. 3. The second case occurs if slabs are layered and crustal rocks are above the serpentinized oceanic mantle, or are mixed with serpentinite material in mélangé zones at the top of the slab (Spandler et al., 2007). Figure 4 portrays the wet solidus curves for the various slab components (Hermann et al., 2006; Kessel et al., 2006) with the aim to explain the interaction between serpentinite fluids and crustal slab rocks. The wet peridotite solidus reported in Fig. 4 is by Stalder et al. (2001), who determined the second critical end point for this system. Also reported in Fig. 4 are the boxes referring to the crystallization conditions of the HP Erro-Tobbio serpentinites, of
the UHP Cignana ophiolites, and of the HP Bétique harzburgites. All peak conditions are close to the wet solidus and to the second critical endpoint of pelitic and granitic systems. Because of the inverted isotherms in subduction zones, fluids released at 650-700°C during antigorite breakdown will heat up as they rise. As a consequence, these uprising fluids will likely trigger the production of melts or supercritical liquids in the sedimentary layers at 750–800°C (Hermann and Green, 2001). Subducted sediments and altered oceanic crust are the major hosts of incompatible trace elements in the subducted crust (Tentheroy and Hermann, 2004). The great majority of LILE is hosted in phengite in these rock types (Hermann, 2002; Spandler et al., 2003). Because phengite is stable to temperatures of 950-1000°C at sub-arc pressures (Schmidt et al. 2004; Hermann and Green, 2001), fluid-absent melting of phengite-bearing metasediments and altered oceanic crust is hardly achieved at sub-arc conditions and it is not regarded to be a viable process to produce LILE enriched slab fluids. In contrast, in the presence of an externally-derived fluid, sediments and altered oceanic crust will undergo fluid-present melting and LILE will preferentially partition into the fluid phase (Hermann and Green, 2001; Kessel et al., 2005). This demonstrates that fluids liberated from subducted ultramafic rocks play a key role in scavenging trace elements from fertile subduction lithologies such as altered basalts and sediments.

**Interaction of subduction zone fluids with the mantle wedge**

Understanding the interaction of hydrous melts/supercritical fluids with the mantle wedge is crucial to define the volatile and trace element recycling in subduction zones. The garnet orthopyroxenites from the Maowu Ultramafic Complex (Dabie Shan, China) are excellent proxies to unravel the slab-to-mantle element transfer at UHP conditions. This body consists of layered meta-harzburgites, garnet orthopyroxenites and websterites associated with coesite-eclogites. Pyroxenites are locally bounded by phlogopite-rich layers, and are hosted by garnet-coesite-bearing gneisses. In this terrane, gneisses and ultramafic rocks share a common UHP history with peak conditions of 4-6 GPa and
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700-750°C (Liou and Zhang, 1998). Although these rocks are not direct samples of a mantle wedge, textural and geochemical data demonstrate that they represent former garnet-peridotites metasomatized by a crust-derived SiO$_2$-rich fluid phase at ~ 4.0 GPa and ~ 750°C (Malaspina et al., 2006). The petrographic observations indicate that the garnet orthopyroxenites preserve a relict paragenesis consisting of olivine + orthopyroxene$_1$ + garnet$_1$ + clinopyroxene$_1$ ± Ti-clinohumite overgrown by coarse-grained orthopyroxene$_2$ (Fig. 5a, b) associated with porphyroblastic inclusion-rich garnet$_1$ (Fig. 5c). Orthopyroxene$_2$ replaces earlier olivine (Fig. 5b) and can include fine-grained garnet$_1$ and orthopyroxene$_1$. This indicates that former mantle phases (i.e. olivine, garnet$_1$, and orthopyroxene$_1$) were replaced by a Si-enriched phase. The major and trace element compositions of whole-rocks and mineral phases support the textural evidence that the protolith of these pyroxenites was a peridotite. They display high Mg$#$ and Ni concentrations and chondrite-normalized REE patterns resembling the ones of a dePLETED mantle (Malaspina et al., 2006). With respect to the inferred harzburgite protholith, however, the Maowu orthopyroxenites are enriched in SiO$_2$ and Al$_2$O$_3$. LREE enrichment characterizes the bulk rocks as well as the replacive orthopyroxene. Such major and trace element compositions of the garnet-orthopyroxenites have been attributed by Malaspina et al. (2006) to the infiltration of a metasomatic melt-like fluid phase rich in SiO$_2$, Al$_2$O$_3$, and incompatible elements sourced from the country-rock gneisses at peak UHP conditions. Reaction of such a SiO$_2$-rich hydrous fluid phase with the peridotite results in a SiO$_2$-and Al$_2$O$_3$-loss from the fluid phase to form the garnet orthopyroxenites. On the other hand, part of the H$_2$O component of the metasomatic agent cannot be accommodated by the newly formed anhydrous phases Opx$_2$ and Grt$_2$, and evolves into a residual aqueous fluid. This free fluid is then occasionally trapped by the growing Grt$_2$ into primary polyphase inclusions (Fig. 5c, d, e, f).

The polyphase inclusions in the Maowu orthopyroxenites therefore provide information on the nature and composition of the residual fluid produced after interaction of the peridotite with the melt-like fluid phase. They display regular negative crystal shapes (Fig. 5c, d, e, f) and contain a solid assemblage (oxide + amphibole + chlorite ± talc ± mica ± apatite) showing constant volume ratios, to suggest that they represent daughter phases that formed from a compositionally homogeneous fluid phase primarily trapped by the UHP garnet. To constrain the nature of such a fluid phase the inclusions have been re-homogenized in a piston cylinder experiment at P=3.5 GPa and T = 900°C (Malaspina et al., 2006). The re-homogenization experiment produced a hydrous porous quench, indicating that the UHP fluid in the inclusions was a solute-rich aqueous fluid rather than a hydrous melt. The composition of this fluid has been investigated with LA-ICP-MS analyses performed on the bulk of both polyphase and experimentally re-homogenized inclusions, following the method developed by Heinrich et al. (2003). The results give a reliable estimate of the trace element composition of the trapped residual fluid. As shown

![Fig. 4](image-url) - Wet solidus curves for ultramafic, mafic, pelitic and granitic systems, showing the second critical end points. The endpoint for ultramafic systems lies at much higher pressures (10 GPa). Boxes refer to the peak P-T conditions for different serpentinite and crustal HP and UHP units of the Alps and of the Betic Cordillera. Redrawn and modified after Hermann et al. (2006).
Fig. 5 – Main textures in orthopyroxenites from Maowu, China. A: coarse replacive orthopyroxene (Opx$_1$) enclosing former garnet (Grt) and orthopyroxene (Opx$_2$). B: blebs of olivine (Ol) replaced by Opx$_2$. C: coarse garnet porphyroblast (Grt$_2$) with primary solid multiphase inclusions at the core. D, E, F: enlargements of solid multiphase inclusions in garnet porphyroblasts, showing the constancy of volume proportions of mineral infillings (D, E) and the type of minerals (chlorite: Chl; K-amphibole: K-amp; amphibole: Amp; pyrite: Py) inside the inclusions (F). After Malaspina et al. (2006).
in Fig. 6, both polyphase and re-homogenized inclusions display very high concentrations of incompatible and fluid-mobile trace elements, with positive spikes in Cs, Ba, Pb, Sr, and a high U–Th ratios. These chemical characteristics provide evidence that the metasomatic agent leading to the formation of the orthopyroxenites had a crustal affinity. The residual aqueous fluid retained most of the incompatible elements that were present in the reacting hydrous-melt. In fact, the whole-rock composition, represented by the white diamonds in Fig. 6, shows relative enrichments only in LREE, whereas most of the fluid-mobile elements are below the detection limit. The reason for this observation is that the rock-forming minerals – orthopyroxene and garnet – are not able to incorporate these incompatible elements. The low LILE contents in the whole-rocks imply that such LILE-enriched fluid largely escaped the system and was only occasionally trapped in garnet, to form the polyphase inclusions. This fluid is able to migrate up into the mantle where it may enhance crystallization of metasomatic amphibole (below 3 GPa; Fumagalli and Poli, 2005) and/or phlogopite, to ultimately reach the locus of partial melting in the mantle wedge.

**DISCUSSION AND CONCLUSIONS**

The presented case studies highlight the importance of ultramafic rocks in the recycling of volatiles and trace elements at convergent plate margins. Serpentinites are the main carriers of water in subduction zones and the breakdown of antigorite liberates large quantities of water at sub-arc depths. Moreover, incompatible elements incorporated during oceanic serpentinitization will be released into the HP-UHP fluid phase once antigorite breaks down. Probably the most important effect on the trace element recycling in subduction zones is that fluids derived from the antigorite breakdown will trigger wet melting in altered basalts and sediments. The produced melts/ supercritical fluids incorporate substantial amounts of incompatible elements, initially residing in the crustal reservoirs. Fig. 7 describes a possible deep subduction environment, where the aqueous fluids released by the serpentinites infiltrate an overlying meta-sedimentary layer to enhance either its partial melting or the production of silicate-rich fluids. The fluid phases that exit the slab will be highly reactive to the surrounding mantle peridotites. This will produce the orthopyroxenite layers described in the Maowu examples and filter the uprising hydrous melt-supercritical fluid phase. The fluid uprising from such filtering zone will be an aqueous, solute-rich solution with composition comparable with the one portrayed in Fig. 6. This fluid equilibrated with mantle rocks through the filtering process and is mobile in the mantle.

A first implication of our case studies thus concerns the mantle wedges above subducting slabs, which can be heterogeneous in composition and layered, due to the presence of reactive pyroxenite bodies. Si-enrichment in the mantle was claimed by previous studies of supra-subduction mantle domains affected by re-fertilization and/or formation of reactive pyroxenites (Kelemen et al., 1998; Yaxley and Green, 1998; Garrido and Bodinier, 1999; Groove et al., 2005). Also, Sobolev et al. (2005) proposed that interaction between recycled crust and mantle peridotites produces pyroxenites in the deep mantle, and melting of such a mantle might contribute to the genesis of ocean island basalts. Here we have detailed a feasible mechanism by which the supra-subduction mantle reacts with slab-derived silicate agents to produce large zones where pyroxenites dominate.

One interesting aspect of this work is that the debate whether trace elements are transported in supercritical fluids or hydrous melts is after all not that essential. Because both these agents are saturated in silica, they will inevitably react with
the silica-undersaturated mantle wedge as outlined in the Maowu case study. During this reaction the fluid phase will be transformed, as Si and Al are extracted from the melt/supercritical fluid, leaving an aqueous, incompatible trace element enriched residual fluid. Hence, while hydrous melt and/or supercritical fluids are important for scavenging incompatible elements from the slab, they are unlikely the agents that transport the metasomatic trace element signature to the source of the arc magmas. Only in the case that the released fluids are channelled in pyroxenite dikes in the mantle wedge, the reaction with mantle olivine would be inhibited and the slab-derived Si- and trace element-rich liquids might migrate into overlying hotter regions of the mantle wedge.

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