Early Paleozoic subduction in Cathaysia: evidence from tectonic mé lange in the northwest Yunkai Domain

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Abstract

The early Palaeozoic tectonic history of the South China has been extensively debated in the last two decades, two contrasting groups of models have been proposed, i.e. subduction collisional belt vs. intracontinental orogen. The Yunkai Domain is one of the most important pre-Devonian metamorphic basement, which is located in the west Cathaysia Block. In this study we report an early Paleozoic subduction-collision related tectonic mélange in the northwest Yunkai Domain, South China. The mé lange is consisted of volcanic rocks, ophiolite fragments and forearc accretion sedimentary complex, with strong deformation of lineation, foliation, fold and thrust fault. We present the detailed LA-ICP-MS zircon U-Pb dating, major and trace element geochemical and Lu-Hf isotopic data for the volcanic rocks and ophiolite fragments. Zircon U-Pb dating shows that the volcanic rocks were erupted at 460 –443 Ma and the intrusion age is 430 Ma. The ophiolite fragments yield the formation age of 455 –437 Ma. The volcanic rocks are composed of high magnesian-magnesian basaltic andesite, allgovite, andesite and dacite rocks, show the affinities of arc related rocks (mostly like sanukite), with LREE, LILE (Rb, Ba, Th and U) enrichment and HFSE (Nb, Ta and Ti) depletion. The ophiolite fragments (basalt, diabase and amphibolite) are similar to those of mafic rocks from supra –subduction zone (SSZ), with LILE (Rb, Ba, Th and U) enrichment HFSE (Nb, Ta, Zr, Hf and Ti) depletion. The volcanic rocks and the ophiolite fragments are similar to those from forearc or arc setting. Zircon Lu-Hf isotopes of the volcanic rocks give negative initial ε Hf(t) values between -4.7 and -0.5. Zircon Lu-Hf isotopes of mafic rocks in the ophiolite give scattered negative initial ε Hf(t) values between -11.0 and +2.3. The ε Hf(t) values of the volcanic rocks and the ophiolite fragments indicate different degrees addition of crustal material into the mantal source. The volcanic rocks and ophiolite fragements of the mélange indicate an ealy Palaeozoic subduction progress was happened in this area. Briefly, our research on the mélange, in combination with early Paleozoic metamorphic features and the widely distributed early Palaeozoic igneous activities, reveal that the tectonic history have experienced subduction accretion orogenic process in the early Palaeozoic, Yunkai Domain, South China.

Acknowledgments

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Keywords: Yunkai Domain, Yunkai tectonic mélange, volcanic rocks, High-magnesia andesite, ophiolite fragments

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Zircon record for prolonged magma chamber processes before the largest Quaternary Toba super-eruption

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The enormous amount of eruptible magmas and the time intervals between large volumes of major eruptions suggest that magmas may need a significant period of time (~ a million years) to accumulate before a supereruption. However, radiometric ages show that the resident time of a magma reservoir is significantly shorter. This study, for the first time, used in situ zircon U-Pb dating and Hf-O isotopes to decipher Toba magma chamber processes, which gave birth to the largest Quaternary eruption on Earth. Besides the well-recognized four eruptions in Pleistocene, magmatic activities of Toba magma chamber can be traced back to 10.5 Ma, followed by infrequent magma intrusion at 5.2 Ma. Age spectrum of zircon indicates that the volume of eruptions correspond to time of magma storage and evolution. The Youngest Toba Tuff (YTT), in particular, record ~ 450,000 years of crystal accumulation in the upper crustal magma chamber before eruption. Such long periods of magma chamber processes were unlikely to be sustained directly by recharge of voluminous basaltic magmas in terms of zircon Hf-O isotopes, but were probably maintained by periodic influx of fluids and silicic magmas melted in depth. Fractional crystallization and accumulation of crystal mush during this interval help to increase the viscosity of the magma and therefore trap the fluids beneath the chamber roof until triggered for explosive eruptions.

Keywords: volcano, super-eruption, zircon U-Pb dating , magma chamber

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Metamorphosed tectonic blocks in the Yuli belt, eastern Taiwan: a petrological perspective

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Rare and small meta-mafic/-andesitic and serpentine bodies scattered in the Yuli belt have long been interpreted as tectonic blocks in literature. Although a mélange-like environment has been proposed, the tectonic setting(s) and geological evolution of the whole Yuli belt remain debating. It is obvious that the tectonic blocks differ greatly from the matrix meta-sediments (mainly pelitic and psammitic with minor chloritic) in terms of whole-rock geochemistry and protolith origin. However, whether they were metamorphosed under the same or different conditions is a critical question yet to be answered. High-pressure metamorphic minerals, such as glaucophane and omphacite, have been identified in many of the tectonic blocks but not in the matrix meta-sediments by far. However, more field observations indicate that the former are embedded within the latter. Therefore, it seems less likely that both were metamorphosed at different physical conditions as previously thought. We have investigated representative litho-types from tectonic blocks and adjacent meta-sediments by using electron-beam microscopy, traditional geothermobarometry, and equilibrium phase diagram modeling. Peak metamorphic temperatures for tectonic blocks and country rocks are fairly consistent at around 500-570˚C, whereas peak metamorphic pressures, although less well constrained, are in the range of 10-17 kbar. These P-T estimates indicate that both tectonic blocks and surrounding meta-sedimentary rocks are coeval in petrotectonic evolution and represent a type of subduction zone metamorphism. The apparent difference in mineral assemblage, metamorphic grade, and texture for some similar or different rock types is misleading and probably reflects complex nature or superimposition controlled by bulk-rock composition, deformation, retrogression, metasomatism, and/or fluid activities.

Keywords: high-pressure metamorphism, subduction, glaucophane, omphacite, melange

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Significance of Zr-in-rutile thermometry for deducing the decompression *P–T* path of a garnet-clinopyroxene granulite in the Moldanubian Zone of the Bohemian Massif

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This work aims to show the importance of Zr-in-rutile thermometry for evaluating the *P–T* history of granulite facies rocks, where higher diffusion rates in the main constituent minerals impede the use of geothermometers based on element distributions. We apply Zr-in-rutile thermometry to a garnet-clinopyroxene (Grt-Cpx) granulite from the Moldanubian Zone of the Bohemian Massif. Three major metamorphic evolutionary stages are identified from the Grt-Cpx granulite. The early high-pressure (HP) stage is represented by an inclusion assemblage in garnet: a high-Ca garnet core (32–38 % grossular, 30–32 % pyrope and 32–35 % almandine) + omphacite (36–39 % jadeite and 3–5 % Ca-Tschermak) + plagioclase (18 % anorthite) + pargasitic amphibole + rutile + zircon + quartz. The subsequent medium-pressure (MP) stage is represented by matrix minerals composed of augitic clinopyroxene (2–6 % jadeite and 2–6 % Ca-Tschermak) + orthopyroxene + ternary feldspar (17–23 % anorthite, 41–44 albite, 33–43 % orthoclase; re-integrated compositions from antiperthite grains in the matrix) + rutile + ilmenite + quartz. The final low-pressure (LP) stage is represented by a symplectic corona composed of calcic plagioclase (~90 % anorthite) + orthopyroxene + magnetite. Application of Grt-Cpx and/or jadeite-quartz-albite geobarometers gives pressures of ~1.8 GPa for the early HP stage and 1.3–1.4 GPa for the MP stage. The final LP stage is constrained to lower than ~0.7 GPa using conventional geothermobarometers. Rutile inclusions in high-grossular garnet have a rather low and limited range of Zr contents (mostly 1100–1500 ppm), regardless of inclusion size. This suggests that rutile inclusions preserved the initial Zr compositions without much modification by later re-equilibration. Application of Zr-in-rutile thermometry yields a temperature of ~830°C at ~1.8 GPa for the early HP stage of granulite evolution. Rutile grains in undeformed clinopyroxene-rich domains of the matrix generally occur as small euhedral crystals and have higher Zr contents (mostly 8000–10000 ppm), corresponding to 980–1066°C at 1.35 GPa using Zr-in-rutile thermometry. In contrast, those in strongly deformed quartz-rich domains of the matrix occur as coarser and more elongated grains with lower Zr contents (3000–5000 ppm), yielding slightly lower temperatures due to retrogressive re-equilibration. Based on these results, we reveal that the studied Grt-Cpx granulite underwent a significant heating by about 200°C during the early stage of decompression from the peak pressure. SHRIMP U-Pb dating for the zircon inclusions in high-grossular garnet indicate that the HP stage of the studied granulite occurred at c.340 Ma, which is indistinguishable to reported LP zircon ages from South Bohemia. Thus, the studied granulite was rapidly heated and exhumed from mantle depth to middle to upper crust in a short period. This rapid heating associated with exhumation was caused by incorporation of the Grt-Cpx granulite into higher temperature felsic granulites which exhumed from deeper parts of the continental collision zone.

Keywords: Zr-in-rutile thermometry, garnet-clinopyroxene barometry, high-pressure granulite, continental collision zone, Bohemian Massif

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Igneous zircons preserving protolith age but internally deformed during the high-pressure metamorphism

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Zircon, a mineral highly resistant to alteration and secondary effect, generally serves as a robust tool to provide accurate age data of the magmatic, metamorphic or detrital origin of the rocks in which it is crystallized, recrystallized or trapped. Most of the published articles on zircon age data mainly report U-Pb age data and associate their results with the geological or tectonic events to their research areas. No doubt, most igneous rocks (plutonic and volcanic both) yield age data fairly accurate and identify the geological event of the rocks which contain those dated zircons.
However, in case of zircons formed or occurring in metamorphic rocks may not yield straight-forward age results. The reasons are (1) presence of inherited detrital or igneous-origin core domains, (2) the overgrowth domains, could be igneous or metamorphic, and (3) the outer rim or late-stage domains. Studying zircons via CL-imaging enables to distinguish such domains if present. However, those domains have been deformed or subject to U, Pb and trace element mobility is not easy to understand. Studying zircon for EBSD may be a useful tool to identify those internal deformations in single zircon crystals. In this paper an EBSD results on already dated zircons form the Himalayan HP eclogites have been presented. The age-data suggest their magmatic origin but several domains preserve internal deformation, probably occurred during the HP Himalayan eclogite facies event.

Keywords: Zircon, age, Eclogites, Internal deformation, High-pressure metamorphism

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Origin of the garnet amphibolites from the Mitsuishi area, western Hokkaido Japan -constraints from the metamorphic petrology and structural analysis-

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Kamuikotan high P/T metamorphic rocks preserve one of the coldest geotherm (0.6 –0.8 GPa/°C) in the Jurassic subduction zone in circum Pacific orogenic belt. The Kamuikotan metamorphic rocks distribute as a belt extending north-south directions in central-western Hokkaido Japan. They suffered blueschist and subsequent greenschist facies metamorphism. However, the origin of the garnet amphibolites is still debatable because they suffered relatively higher P and T conditions, and exhibits as blocks in the serpentinites. Ueda et al. (2013) and Ueda & Orihashi (2014, 2015) have revealed several important new discoveries as follows, 1) origin of the garnet amphibolites are subducted warm oceanic crust 2) they overprinted blueschist facies metamorphism. Based on these important contribution of Ueda`s work, we have described garnet amphibolite blocks. Additional new things are follows. 1) Garnet amphibolites had reached amphibole decomposition temperature fields, producing rutile and zircons. 2) Garnets have relative high Ca core and Ca poor rims. 3) The garnet amphibolite blocks suffered L-tectonite (constrictional) type strain during cooling stage. Amphibole and white mica were rotated along YZ axis and garnets had overgrown and recrystallized showing snowball and S shape structure in the YZ sections. Above these features suggest that garnet amphibolites were separated from suducted crustal layers in dehydration/melting process, and that hydration and constrictional strain process were operated during exhumation stage in cold subduction zone.

Keywords: high grade blocks in serpentinite, dehydrated warm blocks into cold subduction zone, constrictional strain in exhumation

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Tectono-metamorphic evolution of the Kurosegawa tectonic belt in Southwest Japan

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The Kurosegawa tectonic belt distributed in Southwest Japan (from Kii peninsula to Kyushu) has a significant role in understanding the tectonics and formation of Japanese Island. The belt is underlain by a serpentinite melange with complicated tectonic block assemblage of granitic rocks, high-temperature (HT)-type metamorphic rocks (metagabbros: Grt-Cpx granulite, Grt amphibolite and Cpx-bearing amphibolite, metapelites: Grt-Crd-St gneiss and Grt-Bt gneiss) and high-pressure (HP)-type metamorphic rocks (metagabbros: Jd-Gln rock, Gln-bearing matagabbro, metabasalt: Lws-Gln schist, metasediments: Phn-Gln+/-Lws schist and Grt-bearing quartzite).
The granitic rocks and the protoliths of the HT-type metagabbros are supposed to be derived from volcanic arc at an active continental margin based on their major, trace, and rare earth element (REE) chemistry. On the other hand, geochemistry of the protoliths of the HP-type metagabbro and metabasalt indicate mid oceanic ridge basalt (MORB)-like precursors. The LA-ICP-MS U-Pb zircon dating of granitic rocks (collected from Nabaenohana, Anan, Mitaki and Yatsushiro areas) gave the Upper Ordovician magmatic ages of ca.450 Ma with the older inherited core ages of 570-3090 Ma. The U-Pb ages of the HT-type gabbros (from Nabaenohana and Yatsushiro areas) have similar magmatic age ranging *ca.* 439, 446 and 453 Ma concordant clusters. The HP-type gabbros (from Engyoji and Yatsushiro areas) show the igneous age of the Late Cambrian (ca. 490 Ma). The detrital U-Pb zircon ages from the HP-type metasediments (from Anan and Yatsushiro areas) range from 430 to 3000 Ma, therefore the sedimentation would be finalized after Silurian. The Rb-Sr isochron ages for the Lws-Gln schist (typical HP-type blue schist) gave 300-270 Ma, which may indicate the age of HP-type metamorphism.
These results show that the Cambrian oceanic magmatic sequence (protoliths of the HP-type gabbros and basalts) covered by Silurian pelagic sediments (protoliths of the HP-type metasediments) subducted to the already existed palaeo-Asian continent and formed an active margin arc system during the Upper Ordovician. The protoliths of the HT-type gabbros and the granitic rocks would be situated in the lower crustal portion and the upper crustal portion of the arc system, respectively. The similar assemblages are present in the South-Kitakami belt and the Nagato tectonic belt suggesting similarities in their origin.

Keywords: U-Pb zircon dating, granitic rocks, HT-metagabbro, HP-metagabbro, Kurosegawa tectonic belt

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Deep subduction and the ultrahigh-pressure metamorphism of a Cretaceous accretionary prism, the Nishisonogi metamorphic rock, western Kyushu, Japan: Finding of diamond-graphite aggregates

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This paper reports new findings of diamond-graphite aggregate (DGA) from the Nishisonogi metamorphic rocks, western Kyushu, which is an ancient subduction complex of Cretaceous in age. The DGA occurs in serpentinites and pelitic schists from a serpentinite melange. There are two occurrences in serpentinites; one is in pseudotachylye-like veins developing in quartz-carbonate rocks associated with serpentinites and the other is in chromitites (Nishiyama et al., 2014). In pelitic schists, the DGA occurs in strongly deformed pyrite porphyroblasts.

Thin sections of the rocks containing DGAs were polished with Al_2O_3 sheets to avoid possible contamination of diamond. No carbon coating was used. All DGAs occur as inclusions of 1 to 10 mm in size. EDS analysis of DGA samples coated with Au shows C peaks, and the Raman spectra of the samples with no coating show 1330 cm^{-1} diamond band together with 1580 cm^{-1} (G) and 2680 cm^{-1} (S1) graphite bands. The SEM-SXES (scanning electron microscope combined with soft X-ray emission spectrometer) methods confirms coexistence of sp^2 and sp^3 structures in the samples, indicating this material is a mixture of diamond and graphite.

Chromitites rarely occur as 1 to 50 cm thick layers in serpentinites, and consist of chromite grains several 100 mm across. DGA occurs as pseudosecondary inclusions in chromite, which show curved alignment of tiny (1 mm in size) inclusions with termination at both ends. Some chromite in the chromitite contains SiO_2 up to 2 wt % and water by 6 - 8 wt %, showing concentric zoning with SiO_2-free chromite.

Quartz-carbonate rocks occur as veins or as massive bodies replacing serpentinite, suggesting its origin as carbonation of serpentinite. They consist mostly of quartz and magnesite with a small amount of dolomite. The pseudotacylyte-like veins occurs as 1 cm thick veins, showing branching and fluid structures. They are completely recrystallized to aggregates of very fine- grained quartz and magnesite with no remant of glass. The DGA occurs as rounded or ovoidal grains 10 mm across, associated with various minerals such as fayalite, wollastonite, Zr-rich rutile, anatase, natural copper, zircon, xenotime, pyroxene ($Na_{0.27}Ca_{0.32}Mg_{0.80}Fe_{0.42}Al_{0.19}Si_{2.02}O_6$), amphibole ($Na_{0.30}Ca_{1.73}Mg_{4.09}Fe_{0.85}Al_{0.13}Si_{8.00}O_{22}(OH)_2$), and unknown mineral of $MgSi_4O_9$ composition. They are all tiny crystals of several mm in size. SiO_2-mineral inclusions in anatase show Raman spectra either of quartz or of none, and the latter may possibly be amorphous.

The pelitic schist in the serpentinite melange consists of chlorite + phengite + albite + quartz with minor pseudomorphs after garnet. It contains strongly deformed pyrite porphyloblasts, in which numerous inclusions of quartz and DGA are found. The quartz inclusions shows Raman spectra of quartz but have peculiar features normally not found in quartz; they are easily damaged by electron beam under the SEM observation, and they show peculiar shapes with promontries. The promontries may be possibly formed by volume increase owing to transition from coesite, and the damage by electron beam may show that they are very fine-grained polycrystalline aggregates.

These DGAs strongly suggest that the serpentinite melange have subducted into the depth of the diamond stability field, although each DGA may have specific origin. The coexistence of diamond and

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graphite in DGAs indicates either graphitization of diamond during the exhumation or diamond formation from graphite during the deep subduction. Some DGAs show platy form, suggesting the latter possibility. However, we have no definite interpretation on this issue at present.
The metamorphic conditions of crystalline schists in the Nishisonogi metamorphic rock is up to 500 ^{o}C and 1.5 GPa (Moribe, 2014MS), not reaching to the stability field of coestie. However, our new finding of DGAs from the pelitic schist may indicate the possibility of deep subduction of not only the serpentinite melange but also the whole metamorphic rocks in this region.
Neither coesite nor diamond has been found from subduction zones in an island arc setting. Our new finding of DGAs shed new light on the subduction zone dynamics at the island arc setting, by indication the deep subduction can occur in these tectonic settings.

Keywords: deep subduction, ultrahigh-pressure metamorpshim, diamond graphite aggregate, Nishisonogi metamorphic rock, pseudotachylyte, serpentinite melange

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Origin of ophiolite pulse and thermal state of the upper mantle in the Ordovician time constrained from the Hayachine-Miyamori Ophiolite

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It is critical to know the thermal history of the mantle in order to better understand the evolution of the earth because the mantle under thermal convection occupies 80vol% of the earth.
The mantle potential temperature (MPT) is a temperature of mantle material adiabatically brought to the surface. The thermal history of the mantle has been examined by revealing secular change of MPT estimated from non-arc basalts and modeled with a parametarized convection model. The so far obtained MPT change and the model, however, cannot resolve episodicity, the critical feature of the earth’s thermal history, which can only be tackled by accumulation of data with higher resolution.
Ophiolite pulses, in which a large number of ophiolites formed in a confined period, are thought to reflect thermal episodes. However, the relationship between the Ordovician ophiolite pulses and the proposed plume model are not clear because of the predominance of arc ophiolites and scarcity of LIPS for the Ordovician pulse. This must be resolved by MPT estimation for the Ordovician mantle, for which two difficulties relevant to arc magma genesis must be overcome: the involvement of H2O and complex thermal state.
In this study, we develop a novel method for MPT estimation for arc environment by using ultramafic dikes from Hayachine-Miyamori Ophiolite, northern Japan. The estimated MPT, melting depth and water content in source mantle are ~1360˚C, ~170km and ~0.15wt% respectively. The geochemical data of the dike indicate passive upwelling of NMORB source-like garnet peridotite from sub-slub mantle without strong influence of slab-derived fluids. The estimated MPT may reflect the global value if operation of small-scale convection is considered. We conclude that the Ordovician upper mantle has a thermal state similar to the current upper mantle. Surface tectonics, such as assembly and breakup of supercontinents and a peculiar water delivery, might be responsible for the Ordovician ophiolite pulse.

Keywords: thermal state of the mantle, mantle potential temperature, ophiolite pulse, arc ophiolite

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Geochemical study of P-type jadeitites (jadeite precipitates) from the New Idria serpentinite body, California

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P-type (fluid precipitation) jadeitite (Tsujimori and Harlow, 2013) is an excellent media to decipher subduction zone fluids and fluid-induced geochemical processes. As the best example of P-type jadeitite, veined jadeitite from the New Idria serpentinite body of the Diablo Range (California, U.S.A.) was investigated. Vein-network textures and growth textures of oscillatory-zoned jadeite crystals suggest that the jadeitite suffered brittle deformations and subsequently brittle microcracks were filled by jadeite precipitates repeatedly. An integrated study of LA-ICPMS trace elements and lithium isotope geochemistry constrain a property of jadeitite-forming high-pressure/low-temperature aqueous fluids and a possible scenario for formation of the veined jadeitite. Compositions of the jadeitite-forming fluids estimated using partitioning coefficients between clinopyroxene and fluids have trace element patterns similar to experimentally-determined fluids in equilibrium with coesite-bearing metasedimentary rocks. In-situ analyses confirmed a wide variation of isotopic composition (from −12 to +7 permil) and abundance (4–68 μg/g); those values show a systematic distribution fitting a curve led by the fluid–rock interaction equation. Geochemical data suggest that deep fluids enriched with some specific elements and light lithium might have migrated to forearc depths along slab–mantle interface from a great depth. During the migration/upwelling process, fluids interacted substantially with various metamorphic rocks in the interface. Various degrees of fluid–rock interaction and stepwise fluid infiltration at forearc depth recorded in New Idria jadeitite give new insights into the behavior and dynamics of aqueous fluids in subduction zone.

Keywords: jadeitite, lithium isotope, subduction zone

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Petrographical and chemical evolution of a troctolites rich section of oceanic crust located directly above a spreading centre, example from Wadi Mahram, Oman ophiolite

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Petrographical and chemical evolution of a troctolites rich section of oceanic crust located directly above a spreading centre, example from Wadi Mahram, Oman ophiolite
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The Maqsad or Sumail massif in the Oman Ophiolite is known for its well defined mantle structural diapir well matching other petrographical and chemical data, allowing us to locate the axis of a former spreading centre. However, most of the studies conducted on this famous massif concerned the mantle section and published data include mantle harzburgites and mantle dykes and intrusions petrology and chemistry. The crustal section in this massif is only locally known in its lowest part located near the mantle/crust boundary. In this study, we conducted a sequential study of the 2 km thick Wadi Mahram crustal section (from mantle-crust boundary to sheeted dyke transition) located directly above the mantle diapir, i.e. directly above the Oman spreading axis.
The crustal column above the Maqsad diapir is exceptionally rich in troctolites as this lithology represent more than the three quaters of the observed facies and is present at any level from the basis to top of the section. Troctolites are layered in the lower levels, close to the mantle-crust transition zone, intercaled with minor olivine gabbros layers, and the layering is crosscut by centimeter scale olivine gabbro dykes. From the middle to the top of the section, vary textured troctolites progressively become become isotropic at the boundary with the sheeted dyke complex. Meter scale olivine gabbros and olivine-free layers are more abundant at the top. Dolerite dyke cutting troctolite and gabbro structures are abundant near the sheeted dyke complex and probably represent its root system.
Down section mineral chemistry evolution show a considerable contrast between the troctolites and the olivine gabbros. The troctolites chemical characteristics seem to be evolving on a large scale with 2 superposed main bodies at the top and the bottom of the section, about 800 m thick, showing a regular evolution probably in relation to magmatic differentiation during fractional crystallisation. A minor block between these 2 main troctolite bodies show a strong chemical scatter in association with variabke textures and minéralogies suggesting that melt mixing and melt/rock reaction were the dominant processes during its formation. Between the layers of troctolites, olivine gabbros layers show petrographical and chemical properties that could have been aquired by local magmatic processes like differentiation in small scaled trapped melt pocket or local melt/rock reaction during melt migration to the surface. As it was already shown by studies on magmatic dykes in the mantle, the presence of differentiated dykes cutting the layered structure at the section bottom show that significant differentiation degree may be reached within the mantle and differentiated melt can be injected from the mantle into the crust. These differentiated melts melt s are however injected during during the late magmatic history of the section as they cut already cooled lower troctolite. Traces of mixing with these differentiated melts are found only at 2 levels kn the crust: at the intermediate vary textured level or at the topmost level, below below the sheeted dyke complex.

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Keywords: Oman Ophiolite, Gabbroic Crust, Mantle diapir, Troctolite

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Detailed imaging of the subduction front in the locked and 2010 Mentawai tsunami earthquake rupture zones from full waveform inversion of seismic reflection data

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The Sumatran subduction zone is one of the most seismically active zones on earth. Since 2004, three great earthquakes (Mw > 8.0) occurred (2004, 2005, 2007), rupturing the forearc region along the megathrust. The 2004 earthquakes also ruptured the frontal section of the megathrust, supposed to be aseismic, generating a destructive tsunami. While the 2005 and 2007 great earthquakes did not generate a powerful tsunami, the 2010 Mw 7.8 earthquakes did by unexpectedly rupturing the updip part of the Mentawai segment, which has already ruptured in 2007 in the forearc region. The northern part of the Mentawai segment, between the 2007/2010 and 2005 rupture zones is still locked and might generate a great earthquake, and possibly a destructive tsunami. Therefore, the understanding of rupturing processes and differences between the different segments of the Sumatran subduction zone are critical to assess rupture potential.

We combined downward continuation, traveltime tomography and full waveform inversion on this 15-km-long streamer and low frequency seismic data to characterize the nature of the accretionary wedge and the plate interface. The downward continuation of the streamer data to the seafloor enhanced the refraction arrivals to be observed from near-zero offset up to far offset. Then, the travel time tomography was used to determine the background velocity from the upper sediments down the top of the oceanic crust. Starting from these velocities, we perform an elastic full waveform inversion to determine the detailed velocity structure of the sub-surface. In both regions, the combination of pre-stack depth migrated seismic images and high resolution velocity results show a low velocity subduction channel with high porosity at the plate interface that connects active frontal thrusts at the toe of accretionary wedge, suggesting that the frontal section of the prism is seismogenic. Computation of the porosity of the sediments determined fluid content along these channels and faults. Active seawward and landward-vergent faults at the front of the subduction could generate a powerful tsunami by moving the seafloor at high depth.

Keywords: Sumatra subduction zone, Tsunami earthquake, Full waveform inversion

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