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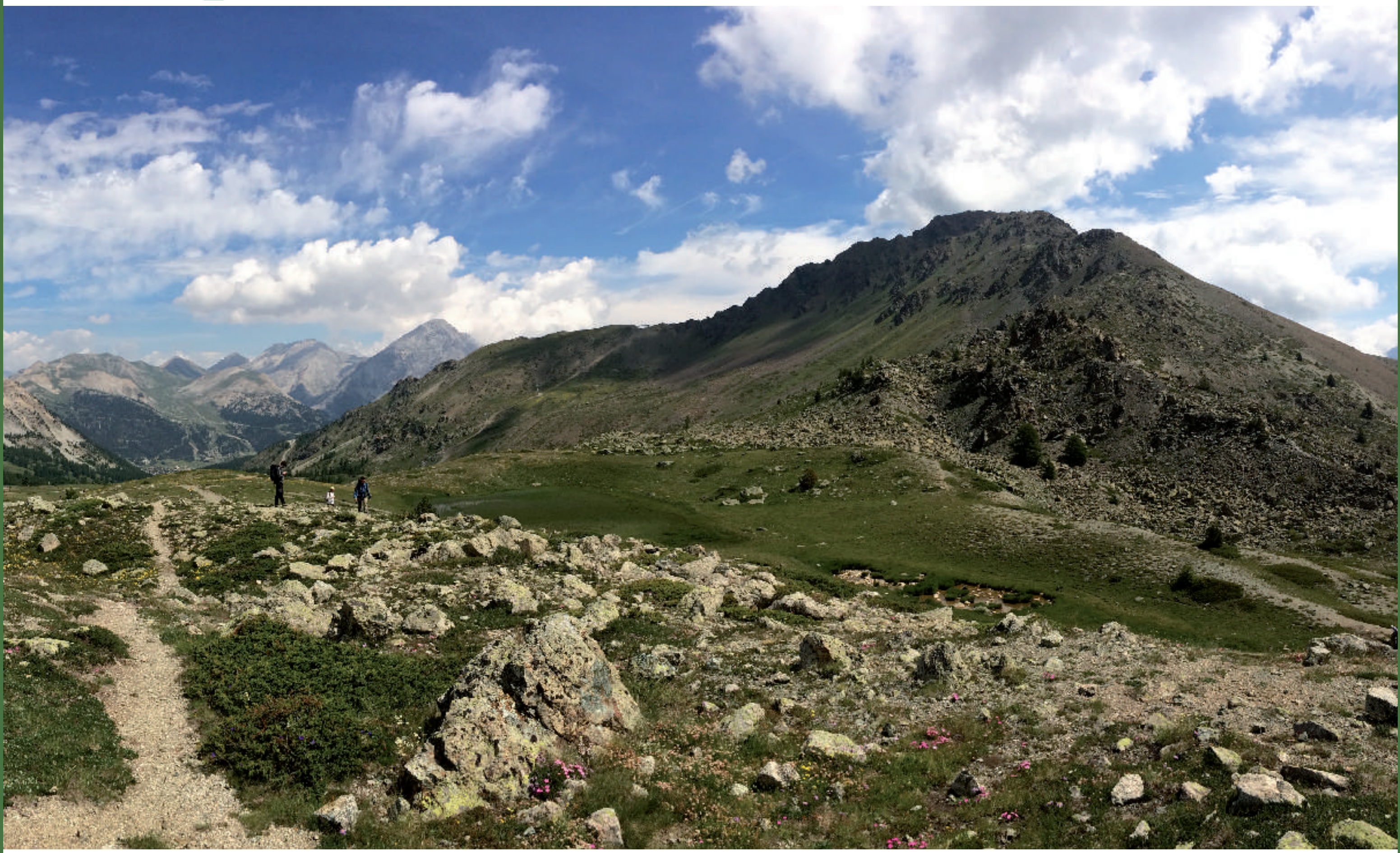

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ABSTRACTS VOLUME

ERLY CRETACEOUS PLUME-RIDGE INTERACTION IN THE BAND-E-ZEYARAT OPHIOLITE (NORTH MAKRAN, IRAN): NEW CONSTRAINTS FROM PETROLOGICAL, MINERAL CHEMISTRY AND GEOCHRONOLOGICAL DATA

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Keywords: *Makran Accretionary Prism, Cretaceous ophiolite, plume-ridge interaction.*

The North Makran domain (southeast Iran) is part of the Makran accretionary wedge and consists of an imbricate stack of continental and Neo-Tethyan oceanic tectonic units. Among these, the Band-e-Zeyarat ophiolite consists of (from bottom to top): ultramafic cumulates, layered gabbros, isotropic gabbros, plagiogranitic dykes and breccias, a sheeted dyke complex, a volcanic sequence, and a pelagic sedimentary cover. Sheeted dykes and volcanic rocks are mainly represented by basalts and minor andesites and rhyolites showing either normal-type (N) or enriched-type (E) mid-ocean ridge basalt affinities (MORB). These conclusions are also supported by mineral chemistry data. In addition, E-MORBs can be subdivided in distinct subtypes based on slightly different but significant light rare earth elements, Th, Nb, TiO_2, and Ta contents. These chemical differences point out for different partial melting conditions of their mantle sources, in terms of source composition, partial melting degrees, and melting depths. N-MORB rocks likely derived from partial melting of a depleted MORB mantle (DMM) source, whereas E-MORB rocks derived from the partial melting of a DMM mantle source slightly enriched by oceanic island basalt (OIB)-chemical components. U-Pb geochronological data on zircons from intrusive rocks gave ages ranging from 122 to 129 Ma. The structural data on this ophiolitic unit indicates a Late Cretaceous - Paleocene-earliest Eocene (?) multiphase deformation history, which is characterized by two folding stages recording accretion and exhumation of this unit within the Makran accretionary wedge. This structural evolution is sealed by the unconformable deposition of Eocenic wedge-top basin successions. These multidisciplinary data suggest that the Band-e-Zeyarat ophiolite represents an Early Cretaceous chemically composite oceanic crust formed in a mid-ocean ridge setting by partial melting of a depleted suboceanic mantle variably metasomatized by plume-type components. This ophiolite records, therefore, an Early Cretaceous plume-ridge interaction in the Makran Neo-Tethys and it was accreted in the Makran accretionary wedge during the Late Cretaceous - Paleocene convergent stages. The Band-e-Zeyarat ophiolite records the early witness of a Cretaceous plume activity that will significantly increase in the Makran area during the Late Cretaceous as recorded in the neighbouring Durkan Complex and Coloured Mélange (Barbero et al., 2021).

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EVOLUTION OF THE OCEANIC MANTLE DURING REACTIVE PERCOLATION OF DEPLETED MELTS IN A THICK LITHOSPHERE (MT. MAGGIORE, CORSICA, FRANCE)

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Keywords: *Alpine ophiolite, Thick Thermal Boundary Layer; Reactive processes, Melt-rock interaction.*

The Alpine ophiolites represent sub-continental and oceanic lithosphere remnants of the narrow Jurassic Ligurian Tethys. They allow the study of the lithospheric evolution during adiabatical melting and melt percolation history in slow-spreading environments. The Mt. Maggiore ultramafic unit (Corsica, France) displays field associations that testify of a complex history of melt reactive percolation from deep levels (spinel facies) to shallower depths (plagioclase facies). We present a field-based microstructural and geochemical investigation of depleted peridotites and associated pyroxenite layers and olivine-rich troctolites. The Mt. Maggiore peridotites display a clear evolution from spinel lherzolite to plagioclase harzburgite during two continuous episodes of melt-rock interaction. At spinel facies, the reactive percolation of a LREE-depleted melt leads to the dissolution of mantle pyroxenes and the growth of olivine crystals, forming replacive spinel dunites. In the shallower plagioclase facies, the melts modified by the previous reactive melt percolation impregnate the spinel-facies lithotypes, leading to the dissolution of olivine and crystallization of plagioclase and orthopyroxene in the peridotites. The impregnation stage is also observed in the spinel dunites, leading to the formation of replacive olivine-rich troctolites.

Additionally, field and petrographic evidence indicate that pyroxenite layers formed prior to the melt–rock interaction history. Moreover, both the parental melts of pyroxenites and the melts involved in the subsequent percolation were characterized by similar Na2O-poor, LREE-depleted compositions. This implies that they represent the continuous evolution of depleted melts leading to different processes (pyroxenite segregation and later melt–rock interaction) during their upward migration. To support the genetic relation and the continuity between the formation of pyroxenites and the subsequent melt–rock interaction history, we modeled all the documented processes in sequence, i.e.: *i)* formation of depleted melts after 6% mantle decompressional fractional melting; *ii)* high-pressure segregation of pyroxenites; *iii)* spinel-facies reactive porous flow, *iv)* plagioclase-facies melt impregnation.

These field-based chemical models allow to constrain all melt percolation features observed at the Mt. Maggiore as resulting from the percolation of a single parental melt in a thick oceanic lithosphere from deep levels to shallow depths.

STRAIN LOCALIZATION AT THE ROOT OF DETACHMENT FAULTS: A MICROSTRUCTURAL STUDY

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Keywords: *Southwest Indian Ridge, lithospheric mantle, deformation processes, detachment fault, grain size reduction.*

The Southwest Indian Ridge (SWIR) in its eastern part is characterized by very low magmatic inputs at ultraslow spreading rates and is therefore a natural laboratory to study oceanic accretion in an extreme thermal configuration. Plate spreading is mainly accommodated by large offset normal faults, also called detachment faults. They exhume mantle peridotites to the seafloor in a nearly amagmatic spreading. These ridge portions are a plausible analog for processes occurring at ridge cold spots as the ridge transform intersections at megatransform domains.

Using 99 samples of partially serpentinized peridotites dredged from the eastern termination of the Southwest Indian Ridge, we characterize the deformation processes active in the root zone of the detachment fault system. The deformation is heterogeneous even at the sample scale and combines both brittle and crystal-plastic mechanisms. Strain localization is initially controlled by grain-scale strength contrasts between olivine and orthopyroxene and among variably oriented olivine crystals. Orthopyroxene deformation is primarily brittle (microfractures), but kinks and dynamic recrystallization are locally observed. In contrast, olivine deforms primarily by dislocation creep with dynamic recrystallization under high deviatoric stresses (80-270 MPa) at high temperature (>800°C). Dynamic recrystallization controlled by strain and stress concentrations produce anastomosing zones of grain size reduction (GSR). This heterogeneous high-stress deformation is observed, with variable intensity, in every sample investigated, suggesting that it was pervasively distributed in the root region of axial detachments.

We use these microstructural observations to constrain a 2D thermomechanical model of lithospheric extension, in which we explore two weakening mechanisms as seen in the samples: serpentinization (T< 350°C) and grain size reduction (T> 800°C). The combination of the two-deformation mechanisms leads to the nucleation of detachment faults in a thick lithosphere evolving to a flipflop pattern similar to that observed at the eastern SWIR (Bickert et al., 2020).

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IN SITU BORON ISOTOPES IN OPHICARBONATES: IMPLICATIONS FOR THE B AND C CYCLES IN SUBDUCTION ZONES

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Keywords: *Boron isotopes, ophicarbonates, LA-MC-ICP-MS, Alps-Apennine ophiolite.*

Ophicarbonates (i.e., carbonated serpentinites) are important lithologies carrying significant amount of water and CO_2 from surficial levels into the deep mantle, thus playing a key role in the volatiles recycling through subduction zone settings at geological timescales. The geochemistry of ophicarbonates has been often limited to the C-O isotopic signatures of carbonates despite other elements hosted in serpentine minerals may provide further information to better unravel ophicarbonate genesis and evolution. Among trace elements that still deserve to be investigated in ophicarbonates, boron (B) is undoubtfully the most promising isotopic systematic. In fact, serpentine minerals are strongly enriched in B and their B isotopic signature is a powerful tracer of fluid-rock interactions. Oceanic serpentinites show that serpentinites are characterized by positive B isotope composition (expressed as $\delta^{11}B$), from +5‰ and approaching seawater value (+39.6‰). In contrast, serpentinites from wedge-derived setting commonly show negative $\delta^{11}B$ signatures, reflecting interaction with slab-derived and ^{11}B-depleted fluids. Data on the B isotopic signature of ophicarbonates are still lacking.

In this contribution, we attempt to fill this knowledge gap by studying ophicarbonates exposed in the Alpine-Apennine ophiolite sequence representing a wide range of *P-T*. We present the first *in situ* B isotope measurement in serpentines from ophicarbonates by using the recently installed LA-MC-ICP-MS instrument at the Earth Science Department (University of Milano). The petrographic features of these rocks are extensively reported in a previous work (Cannaò et al., 2020) together with their whole-rock and *in situ* geochemistry coupled with C-O and Sr isotopic signatures of carbonates. Our data highlight how hydrothermal processes may have a strong impact in the evolution of the B isotope systematic in ophicarbonates, thus influencing the B budget of these rocks entering and evolving in convergent margins. As serpentinites highly govern the H_2O budgets of subducting materials, the fluids released during the antigorite breakdown at high-*P* in ophicarbonates will also control dissolution of carbonates allowing C mobilization that may significantly impacts on the global C cycle.

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PRELIMINARY DATA ON THE TECTONOSTRATIGRAPHIC RECONSTRUCTION OF THE INTERNAL PIEDMONT ZONE META-OPHIOLITE IN THE STURA DI VIÙ VALLEY (WESTERN ALPS)

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Keywords: *tectonostratigraphy, Piedmont Zone, meta-ophiolite, Western Alps, intra-oceanic tectonics*

Meta-ophiolites outcropping in the axial sector of the Western Alps are classically interpreted as remnants of the Late Jurassic Alpine Tethys (i.e., the Internal Piedmont Zone, IPZ). In the Lanzo Valleys (in particular the Stura di Viù Valley), meta-ophiolites widely crop out, and represent a portion of oceanic basement with its metasedimentary cover. Several meso-scale evidences, which escaped the strong deformation and the related alpine metamorphic overprint, allow reconstructing the original setting of the oceanic lithosphere of the IPZ around Malciaussia Lake.

In the study area, the IPZ consists of a meta-ophiolitic basement (serpentinized peridotite, metabasalts and rare Mg-Al metagabbros) and its metasedimentary cover (quartzite, grey marble and calcschist). The succession was deformed mostly by the D1 and D2 Alpine folding phases, both parallelizing the original stratigraphy to the S1 and S2 respective foliations. Litostratigraphic contacts, preserved by the deformation, permitted to define different litho-stratigraphic cross-sections, whose correlation highlights the variable physiography of the ocean floor at Jurassic time.

As a preliminary result, we interpreted the different sequences as expression of Jurassic extensional intra-oceanic tectonics, realizing discontinuous and pronounced high and low structural sectors of the exhumed mantle (pre-rift step), above which volcanites (with their reworked products) and the pelagic cover (quarzite and marble) mainly remain confined in the low structural sectors (syn-rift to post-rift step).

The subsequent thick calcschist succession seals off the morphology inherited from the extensional tectonics (post-rift step). In particular, the presence of a structural high sector, consisting of serpentinites, surrounded by lower basins with different bathymetry is very evident. The occurrence of deep sectors, wherein mafic meta-greywacke and quarzite deposited, adjacent to higher sectors, wherein serpentinitic basement are directly in contact with the higher portions of the calcschist succession, suggest that the intra-oceanic tectonics, related to the opening of the Alpine Tethys, may were driven by transtensive (transform) tectonic regimes. Low structural sectors may represent original pull-apart basins, separated in the adjacent sectors by the higher sectors through high-angle faults.

NEW STRUCTURAL, PETROLOGICAL AND GEOCHRONOLOGICAL CONSTRAINTS FROM THE META-OPHIOLITES OF THE SUSA VALLEY (WESTERN ALPS)

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Keywords: *Structural geology, Petrology, Geochronology, Western Alps, meta-ophiolites*

T A multidisciplinary approach to the study of orogenic belts allows obtaining a better knowledge of their geodynamic evolution. In this work (result of the PhD project), the focus is on different shear zones acting at different depths, and on the relationships with the adjacent tectonic units. Obtained data (geological mapping, structural analysis, metamorphic evolution and radiometric ages) provided several information on the multistage exhumation of (U)HP meta-ophiolites of the Piedmont Zone, occurring along the Susa Valley (NW Italy).

The Piedmont Zone is subdivided in Internal (IPZ) and External (EPZ) zones, based on their metamorphic peak (eclogite-facies and blueschist-facies conditions, respectively) and lithostratigraphic features. IPZ and EPZ were deformed by 4 regional deformation phases (D1 to D4). In addition, IPZ and EPZ were coupled by a first-order polyphasic shear zone, the Susa Shear Zone (SSZ), which drove their exhumation. The SSZ is a thick shear zone, wherein two distinct generations of kinematic indicators occur (T1 and T2), showing opposite shear sense (Top-to-E and Top-to-W, respectively).

Metamorphic evolution of IPZ and EPZ was achieved using pseudosections and stable mineral assemblages on mafic and meta-pelitic rocks. In IPZ, 4 metamorphic events were recognized: i) peak-P conditions, at eclogite-UHP boundary, ii) prograde decompressive stage, still in eclogite-facies, iii) greenschist re-equilibration, iv) isobaric late heating (greenschist-amphibolite boundary). In EPZ, 3 metamorphic events were preserved: i) peak-P in blueschist conditions, ii) greenschist re-equilibration, iii) isobaric late heating (high-T greenschist). Metamorphic events were correlated to the deformation recognized at the mesoscale. Metamorphic foliations (referred to D1, D2 and T1) were dated by in situ Ar/Ar on white mica. D1 foliations (IPZ and EPZ) developed at ~46-41 Ma, while D2 foliations (IPZ and EPZ) developed at ~39-36 Ma. T1-realted mylonitic foliation developed coeval with the D2 (~39-36 Ma).

Obtained data constrained a geodynamic model, for the exhumation of the IPZ and EPZ, distinguished into 4 stages. The first stage (D1), in the IPZ, represent the path from the peak-P to the coupling with the underlying Dora Maira. In this time-lapse, EPZ reached its peak- P conditions.

The second stage (D2) occurred when IPZ and EPZ were exhumed towards W, with different exhumation rates, along the T1-related shear zone, resulting from higher exhumation speed of IPZ than EPZ. Coupled IPZ and EPZ suffered a subsequent folding, due to the doming (D3). This interpretation explains the T1 apparent reverse kinematics recorded along the SSZ. The late exhumation event (D4) occurred when the coupled meta-ophiolitic units reached upper crustal levels, triggering the EPZ tectonic collapse. The relative movement of the IPZ below the EPZ were driven by T2-related shear zones, which display Top-to-W extensional tectonics.

OCEANIC TECTONOSTRATIGRAPHY AND ALPINE STRUCTURAL EVOLUTION OF THE QUEYRAS OPHIOLITE IN THE MAIRA VALLEY (WESTERN ALPS)

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Keywords: *Western Alps, ophiolites, Schistes Lustrés, Alpine tectonics*

In the Queyras Complex, different units deriving from the tectonic dismemberment of the Jurassic Ligurian-Piedmont Ocean Basin, were juxtaposed during the Alpine tectonic stage and blueschist-facies metamorphism to form the Alpine accretionary complex (Tricart & Lemoine, 1991; Lagabrielle, 1994; Balestro et al., 2019). In the Mollasco Valley (Upper Maira Valley, Western Alps), the uppermost tectonic unit of the Queyras Complex is in tectonic contact with the Briançonnais Units of the paleo-European continental margin.

Detailed geological mapping, together with stratigraphic observations and meso- and micro-structural analyses, led to better defining the lithostratigraphic succession and understanding the structural evolution of this sector of the Queyras Complex. The latter consists of meta-ophiolite blocks ranging in size from few meters to several hundreds of meters, embedded in a calcschist successions (i.e. the so-called *Schistes lustrés*), hundreds of meters thick. In the study area, blocks consist of (i) serpentinized peridotite, locally overlain by horizons of meta-ophicarbonate, (ii) metabasalt, derived from both pillow lava and volcanic breccia, and (iii) discontinuous horizons of meta-chert and whitish marble, up to few meters in thickness.

Structural analysis allows to distinguish three different deformation phases, named D1, D2 and D3 from the oldest to the youngest, respectively. The D1 is documented by foliation S1, locally preserved in D2-fold hinges and lithons, and by boudins and pinch-and-swell structures, which result from S1-parallel stretching. The D2 deformation phase is characterized by close to isoclinal non-cylindrical folds, SSW-verging, developing an axial plane foliation (S2). The S2, which corresponds to the regional foliation, is mainly SSW dipping and widely obliterates the S1. Boudinage of folded limbs and a later top-to-N dextral shearing also occur during D2. The third deformation phase (D3) is characterized by open to gentle folds, not developing axial plane foliation.

Preliminary structural analyses highlight that D2- and D3-related deformation developed during exhumation of the Queyras Complex, whereas D1 structures formed during subduction and early building of the Alpine accretionary wedge.

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NATURAL ASBESTOS OCCURRENCES IN SOUTHERN APENNINES AS A CONCERN TO HUMAN HEALTH: MINERAL FIBRES CHARACTERIZATION

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Keywords: *asbestos fibres, PTEs, ophiolites, Southern Apennines,*

Today, it is widely accepted by the scientific community that the exposure to asbestos brings to the development of negative health issues (IARC, 2012; Harper 2008; Baumann et al., 2015). Although many countries banned the use and the commercialization of asbestos, the environmental exposure of people still represent a big concern. In fact, the Natural Asbestos Occurrences (NOA) interest some areas of the Italian territory as well as various parts of the world (e.g., Harper 2008, Bloise et al., 2021). Ophiolite rocks (i.e. serpentinite and metabasite) are the main lithotypes associated with NOA since asbestos minerals are the major constituents of these rocks. Moreover, derivative soils inheriting the mineralogical and geochemical characteristics of the bed rock may contain hazardous fibres, thus representing a source of risk to human health (Punturo et al., 2018; Ricchiuti et al., 2020). The hazard is based on the potential inhalation of mineral fibres dispersed into the environment because of weathering processes (e.g. erosion) or human activities (e.g. road construction, excavation, agricultural activities) that may disturb NOA thus causing the release of dust containing respirable fibres into the air.

Another notable aspect is represented by the capability of fibres to host potentially toxic elements (PTEs; i.e., Fe, Cr, Ni, Zn, Mn, Co and REEs), which may be released into the organism thus causing health issues (Bloise et al., 2020).

In this scenario, the present contribution aims to show the activities of our research group conducted on rocks (serpentinite and metabasite) and derivative soils samples occurring in the Southern Apennines. The main goal of our work is to show as the rock samples may be characterized by using various analytical techniques (i.e. OM, SEM-EDS, TEM-EDS, XRPD, XRF, ICP-MS, SR-μCT) in order to determine the presence of asbestos fibres as well as that of PTEs, if any.

Results of our studies, showed that Southern Apennines are characterized by asbestos fibre occurrences (e.g. chrysotile, tremolite, actinolite) and that in some areas the concentration levels of toxic elements such as Cr, Co, Ni and V in serpentinite rocks and derivative soils exceed the regulatory thresholds for public, private and residential green use (Punturo et al., 2018). In this regard, the PTEs quantification is essential to limit exposure and minimize the public health risks for people living in these geological contexts.

Finally, with our research activities we want to: i) improve the characterization and quantification related to asbestos fibres contained in both ophiolite rocks and derivative soils; ii) provide data for compulsory Italian asbestos mapping; iii) identify eventually health hazard areas owing to asbestos and other fibrous minerals presence.

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AMPHIBOLE-BEARING MAFIC-ULTRAMAFIC INTRUSIVES IN A NASCENT ARC SETTING (MASSIF DU SUD, NEW CALEDONIA)

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Keywords: *subduction zones, hydrous intrusives, New Caledonia*

The New Caledonia ophiolite hosts one of the best-preserved sections of a nascent arc, providing a unique insight into the early life stages of subduction systems.

The sequence, formed at the onset of the Eocene subduction, consists of depleted forearc harzburgites (Secchiari et al., 2020), locally capped by mafic-ultramafic rocks (Marchesi et al., 2009; Pirard et al., 2013; Secchiari et al., 2018). The ultramafic intrusives (dunites and wehrlites) originated from melt-rock reactions involving boninitic to arc-tholeiitic melts. Conversely, the gabbronorite cumulates derived from depleted H_2O-poor magmas transitional toward tholeiites.

Here, we report the first occurrence of amph-bearing intrusives in the New Caledonia sequence. We present a petrological and geochemical characterization of a 500 m-thick pyroxenite intrusion and crosscutting mafic-ultramafic dikes. The studied rock-types are medium-grain websterites, mainly composed of Opx (~ 30-75 vol.%) and Cpx (~ 20-40 vol.%), with variable amounts of edenitic amphibole (~ 2-30 vol.%). Amphibole occurs as oikocrysts or develops as overgrowths on pyroxenes. High-Ca plagioclase (An_{83}-An_{96}) is scarce in the websterites (~ 2 vol.%), but more abundant in the dikes (~ 10-50 vol.%). Cpx shows variable Mg# (0.82-0.92) and low Al_2O_3 (0.99-2.00 wt%). Likewise, amphibole yields high Mg# (0.712-0.865). Estimated equilibrium T based on conventional pyroxene thermometry range between 870-970°C, whereas slightly lower values (800-910 °C) are given by amphibole-plagioclase pairs.

Whole rocks have moderate Mg# (71-82) and REE contents between 1 to 5 times chondrites.

The websterites of the main body exhibit LREE-depleted (La_N/Nd_N=0.5-0.8), weakly concave downward patterns, with flat HREE (Lu_N/Tm_N=1.1-1.3). The associated dikes have similar patterns, bearing depleted to flat LREE (La_N/Nd_N=0.6-1) and positive Eu spikes. Extended trace element diagrams point out FME (i.e. Rb, Ba, U) and Th enrichments, coupled to Zr-Hf depletion.

Putative melts in equilibrium with the websterites indicate intermediate Mg# (57–63) and incompatible trace element patterns strongly recalling those of the New Caledonia boninites (Cluzel et al., 2016). However, they considerably differ from the equilibrium melts reported for the other intrusive rocks of the sequence (Marchesi et al., 2009; Secchiari et al., 2018).

Our results suggest that petrological and geochemical heterogeneity of the early arc products may be a hallmark of the subduction inception.

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SEAFLOOR SPREADING AT THE CHARLIE GIBBS TRANSFORM SYSTEM (52-53ºN, MID ATLANTIC RIDGE): PRELIMINARY RESULTS FROM AKADEMIK NIKOLAJ STRAKHOV EXPEDITION S50

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Keywords: *Slow-spreading ridge, Intra-transform spreading center, Bathymetric and magnetic data.*

The Charlie Gibbs offsetting by ~340 km the Mid Atlantic Ridge (MAR) axis between 52°-53° N is one of the main transform systems of the North Atlantic. Located between long mid-ocean ridge segments influenced to the south by the Azores and to the north by the Iceland mantle plume, this transform system has been active since the early phases of North Atlantic rifting. Object of several surveys in the '70 and '80, Charlie Gibbs received great attention for its unique structure characterized by two long-lived right-lateral transform faults linked by a short ~40 km-long intra-transform spreading ridge (ITR) with parallel fracture zone valleys extending continuously towards the continental margins. In October 2020 expedition S50 of the R/V A.N. Strakhov surveyed an area of 54552 km^2 covering the entire Charlie Gibbs transform system and the adjacent MAR spreading segments. We collected new bathymetric, magnetic, and high-resolution single channel seismic data, along with basaltic, gabbroic and mantle rocks from 21 dredges. This work contains preliminary data from cruise S50 and discusses the large-scale architecture of this unique, long-lived transform system.

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NEW PERSPECTIVES ON IN SITU ISOTOPE VARIATIONS IN GEOLOGICAL MATERIALS

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Keywords: *laser ablation, MC-ICP-MS, isotopes.*

In situ elemental determinations are nowadays routinely used in igneous and metamorphic petrology and laser ablation (LA)-ICP-MS is by far the most used instrument. With the advent of a new generation of MC-ICP-MS and laser ablation systems which are capable of precise in situ isotope determinations (e.g., Zhang and Hu, 2020), isotopic disequilibria at the micron scale were detected in many geological materials and recognized of primary importance for petrological reconstructions (e.g. Ramos and Teply III, 2008).

In the frame of the MIUR project Department of Excellence (2018-2022) the Earth Science Department "A. Desio" of the University of Milano has installed a new laboratory for the *in situ* elemental and isotopic characterization of geological and environmental materials. The laboratory is equipped with the last generation laser ablation microprobe (Teledyne CETAC Analyte Excite) and with two ICP-MS equipped with single (Thermo iCAP-RQ) and multi-collector (Thermo Neptune XT) ion detection systems. The single-collector ICP-MS is a quadrupole used for the determination of the trace element content in minerals and for U-Pb geochronology on common accessory phases (zircon, rutile). The MC-ICP-MS is equipped with one ion counter and nine Faradays collectors with 10^{11} Ω resistors. The availability of two additional 10^{13} Ω resistors allows very low signal/noise ratios and thus the acquisition of very low signals such as those given by the laser ablation sample introduction system on minor isotopes (e.g., ^{6}Li, ^{10}B).

The major impediments in the development of accurate and precise methods for *in situ* isotope determinations on geological materials are signal intensities giving geologically meaningful errors and the availability of external standards to correct for the large mass fractionation effects resulting from laser sampling, ionization and ion transfer in the MC-ICP-MS.

In our new laboratory, the methodological development was focused on B, Sr and Hf systematics in minerals of common use in igneous and metamorphic petrology such as micas, serpentines, plagioclase, tourmaline, amphibole and zircon. In this contribution, we will give an overview of the analytical capabilities of the new laboratory with examples of application to natural case studies. Particular attention will be given to the discussion of the influence of mineral matrix, elemental concentration, parent/daughter elemental ratios and spot size on accuracy and precision of isotope data.

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SCIENTIFIC DRILLING IN THE IVREA-VERBANO ZONE: A DIVE INTO THE CONTINENTAL MOHO

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Keywords: *Scientific Drilling, Continental Moho, Lower Continental Crust*

What makes planet Earth unique? Together with water and life, it is plate tectonics. One of its characteristic processes is chemical differentiation, forming a SiO_2-rich continental crust that is continuously shaped and reworked throughout Wilson cycles. The continental crust (CC) covers 41% of Earth's surface and sits at higher elevation compared to the oceanic crust that is then largely subducted. The SiO_2-rich rocks that dominate the upper portions of Earth's continental crust are unique in the Solar System and are ultimately linked to the presence of liquid water on Earth. But what does the bottom of the continental crust look like? And how deep can we find life within the crust? The upper crust is accessible for geological sampling and measurements, but its deeper portions, especially the crust–mantle transition zone (the "Moho"), are usually beyond reach. The Moho is mostly a pencil-head drawn interface on geophysical images, but its true nature and transitional characteristics are mostly speculative. As this zone acts as a primary density and enthalpy filter, it holds critical information on how mantle-derived magmas are modified by chemical differentiation, hybridization and mixing processes. Establishing the link between magma generation, transport, and emplacement is therefore essential to significantly improve our understanding of crust-forming processes associated with plate tectonics, and help determine the Earth's crust architecture and composition and relations to the mantle.

Scientific Drilling in the Ivrea-Verbano ZonE (project DIVE, supported by ICDP), the worldwide known natural laboratory to address the questions about the roots of the continents will literally DIVE to the targeted depths to unravel the: • Petrological sections of the Lower CC and its transition to the upper mantle • Physical characteristics of the crust–mantle transition zone through its geophysical signatures • Rheology of continental roots through the distribution of brittle and ductile deformation • Lower crust as a dynamic environment for fluid flow, fluid-rock reactions, and volatile cycles • Extreme niches for hosting microbial activities in planetary interiors. Acquiring data to address the aforementioned overarching objectives will enable fundamental progress towards understanding the structure, composition, and dynamics of the Earth's lower crust and its transition to the mantle, as well as its potential importance for life on Earth.