

Re-evaluating the South Cyclades shear zone, Ios, Greece

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Abstract

Metamorphic core complexes (MCC) are large-scale extensional structures that exhume mid- to lower- crustal rocks beneath low-angle detachment systems and provide important insight into the processes of crustal deformation, metamorphism, and tectonic exhumation. The island of Ios, Greece, has long been regarded as a classic example of an MCC, where exhumation of the Cycladic Basement (CB) has traditionally been attributed to Miocene displacement along the so-called South Cyclades Shear Zone (SCSZ). However, the structural evolution of the island remains controversial due to the preservation of opposing kinematic indicators, and complex overprinting relationships. This study re-evaluates the tectonic evolution of Ios through detailed field mapping, structural analysis, petrography, and in-situ white mica $^{87}\text{Rb}/^{87}\text{Sr}$ geochronology. Emphasis is placed on the relationships between folding, foliation development, shearing, and the nature of the contact between the Cycladic Basement and Cycladic Blueschist Unit (CBU). Field observations demonstrate that both units preserve a pervasive schistose foliation (S_2) that is cut by a regionally developed axial planar cleavage (S_3), which overprints mineral assemblages and mylonitized fabrics. Opposing top-to-north and top-to-south kinematic indicators occur within the same lithologies, structural domains, and are commonly preserved with folded fabrics. These relationships suggest that many apparent kinematic reversals result from structural rotation during folding rather than recording discrete episodes of opposing shear. White mica in-situ $^{87}\text{Rb}/^{87}\text{Sr}$ geochronology from both units suggests a similar exhumation history, where retrograde related recrystallization occurred between c. 30-20 Ma, matching similar ages previously published for the island. The CB-CBU contact lacks a consistent strain gradient, metamorphic discontinuity, and structural continuity expected of a crustal-scale detachment zone. Instead, it is interpreted as a folded lithological boundary that shared a common tectonometamorphic and exhumation history. A younger top-to-north Headland Shear Zone locally overprints earlier fabrics and represents the latest recognized phase of ductile deformation on the island. Collectively, these observations challenge traditional interpretations of Ios as a classical metamorphic core complex and highlight the importance of structural inheritance, polyphase deformation, and fold-related modification of kinematic indicators when reconstructing the evolution of extended continental crust.

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Introduction

Metamorphic core complexes (MCC) are tectonic plate-scale extensional structures that expose the middle and lower crust, which was exhumed beneath an extending and fracturing upper crust. First recognized in the North American Cordillera, MCCs were initially considered unique to that tectonic setting, but have since been documented in a range of extensional environments worldwide (Davis and Coney, 1979; Coney, 1980; Wernicke, 1981). Their development is commonly associated with lithospheric extension and tectonic denudation, processes that exhume deep seated rocks previously metamorphosed from depths below the brittle-ductile transition. As such, MCCs provide important records of the transition from crustal thickening and metamorphism during orogenesis to subsequent post-orogenic extension and exhumation. In many examples, extension is accompanied by syn-tectonic magmatism, anatexis, and lower crustal flow, highlighting the strong coupling between deformation, thermal evolution, and crustal rheology (Lister and Davis, 1989; Whitney et al., 2013).

The classical MCC architecture consists of a ductilely deformed lower plate (footwall) separated from a brittle upper plate (hanging wall) by a low-angle normal fault or extensional detachment shear zone (Lister and Davis, 1989; Teyssier and Whitney, 2002). The footwall typically comprises medium to high grade metamorphic and plutonic rocks that preserve evidence of progressive exhumation under cooling conditions, including mylonitic fabrics, strain localization toward the detachment plane, and retrograde metamorphism during uplift (Coney, 1980; Lister and Davis, 1989; Cooper et al., 2017). Detachment zones within MCC are usually up to ~1 km-thick ductile shear zone with mylonites, cataclasites, breccias, and a low-angle, normal-sense fault plane exhibiting extensional fabrics (Anderson, 1951; Malavieille, 1993). The footwall records deformation across the brittle-ductile transition, and evidence of not only the

latest extensional deformation, but may also preserve earlier tectonic events that pre-date development of the extensional system itself. The hanging wall consists of relatively shallow, brittle upper crustal assemblages composed of weakly metamorphosed to unmetamorphosed sedimentary, volcanic, or crystalline rock that was translated away from the exhuming core (Coney, 1980; Platt et al., 2015). These rocks were already at relatively shallow levels prior to the onset of extension, and in well exposed examples, are cut by numerous normal faults, producing domino-style tilted blocks. Together, these components form an integrated structural system linking deep-crustal exhumation with upper-crustal extension. A distinct break in metamorphic grade at this contact, as a boundary between the higher-grade lower plate and overlying lower grade upper plate, is also a hallmark of the MCC.

Despite their widespread application as models for crustal exhumation, identifying MCCs in the field is not always straightforward. Structures commonly attributed to extensional deformation may instead be modified pre-existing contractional fabrics, inherited shear zones, or an even younger tectonic overprint (Coney, 1980). Footwall rocks frequently preserve evidence of prograde (pre-extensional) metamorphism, folding, and transposition associated with crustal shortening and thickening, whereas later deformation may rotate, reactivate, or fold these structures. Consequently, kinematic indicators, strain gradients, and shear zone geometries may not provide an unambiguous record of extensional exhumation. In structurally complex terranes, distinguishing between inherited and extensional fabrics remains one of the principal challenges in evaluating MCC evolution (Baldwin et al., 1993; Whitney et al., 2004). Baldwin et al. (1993) emphasized that some of the clearest examples of MCC development occur in actively extending regions where later tectonic overprinting is minimal, allowing extensional structures and exhumation cooling histories to remain relatively well preserved. In older and more structurally

complex terranes, however, deciphering the relative timing of contractional, extensional, and post-extensional deformation remains a significant challenge and continues to motivate reinterpretation of many established MCC systems.

The Cycladic islands of the Aegean Sea represent one of the world's best preserved natural laboratories for investigating post-orogenic extension and metamorphic core complex development (Figure 1). Extension in the region was driven by slab rollback and back-arc spreading associated with subduction of the African plate beneath Eurasia during the Cenozoic (Jolivet and Brun, 2010). Ios, and nearby Naxos, have long been considered an archetype example of a Cordilleran MCC (Lister et al., 1984), characterized by a domal structure in which the Cycladic Basement (CB) is structurally overlain by the Cycladic Blueschist Unit (CBU) and separated by the South Cyclades Shear Zone (SCSZ), a structure widely interpreted as a major extensional detachment responsible for Miocene exhumation (Forster and Lister, 2019). More recent studies, however, have documented multiple generations of folding as evinced by crenulation cleavage, transposition fabrics, and overprinting shear zones that complicate this interpretation (Huet et al., 2009; Flansburg et al., 2019; Wolfe et al., 2023; Tsourtis et al., 2025; Flansburg et al., 2026). In particular, the recognition of overturned folds and variably overprinted high strain fabrics raises questions regarding the extent to which structures on Ios are solely related to extensional exhumation, or whether they instead preserve evidence of earlier compressional deformation that has subsequently been reworked during extension (Forster and Lister, 1999; Huet et al., 2009; Flansburg et al., 2019; Wolfe et al., 2023). These observations raise questions regarding the extent to which structures on Ios record extensional exhumation versus inherited deformation that has been subsequently reworked during extension.

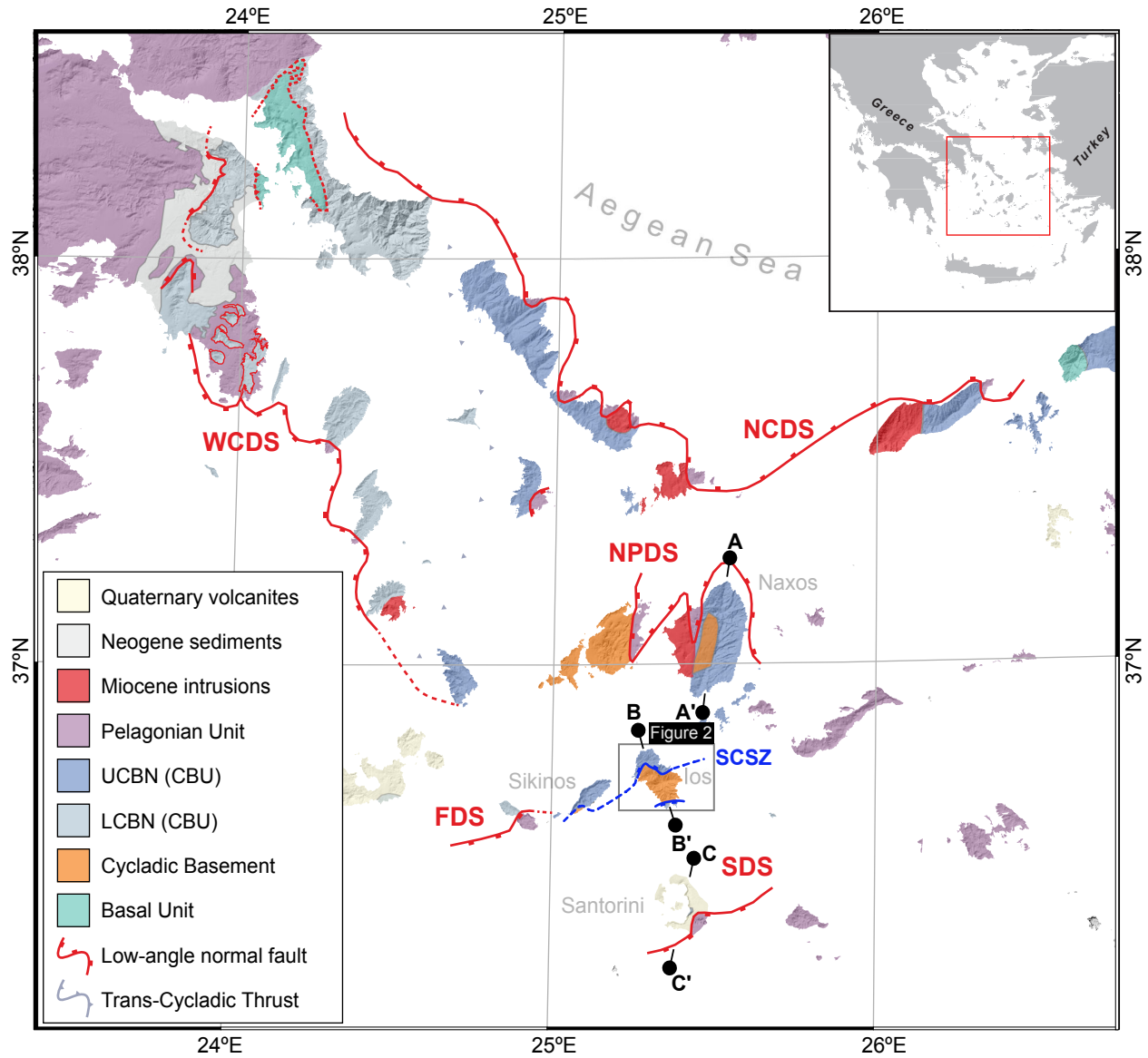


Figure 1. Simplified geological map of the Cyclades, Greece, highlighting the Miocene post-orogenic low-angle extensional detachment systems (red) including the West Cycladic Detachment System (WCDS), North Cycladic Detachment System (NCDS), Naxos-Paros Detachment System (NPDS), Folegandros Detachment System (FDS), as well as the Santorini Detachment System (SDS). The so-called South Cyclades Shear Zone (SCSZ) is noted in blue. A grey box demarcates Ios island, and black pins specify transect profiles in Figure 17. Modified after Grasemann et al. (2018) and Bakowsky et al. (2025).

This study aims to test the hypothesis that the structural architecture of Ios is consistent with exhumation through a metamorphic core complex, characterized by displacement along a regionally significant extensional detachment system separating the Cycladic Basement (CB) and Cycladic Blueschist Unit (CBU). If the proposed MCC model adequately explains the structural evolution of Ios, several key characteristics should be identifiable within the geological record. These include; (1) a laterally continuous, tectonically significant shear zone associated with the proposed CB–CBU detachment, (2) a spatial distribution of ductile strain and shear-related fabrics consistent with localization toward the proposed detachment, (3) kinematic indicators and overprinting relationships (cold structures overprinting warm structures) that establish the relative timing of shearing and folding, and (4) geochronological constraints compatible with the proposed sequence of deformation, metamorphism, and exhumation. Alternatively, if Ios does not represent a classical metamorphic core complex, its present-day architecture may reflect a gneiss dome subsequently modified by polyphase folding and uplift. In this hypothetical model, the CB-CBU contact would instead represent a folded lithological boundary rather than a tectonic detachment, with the island's structural geometry primarily controlled by distributed pervasive deformation rather than localized extensional shearing.

To evaluate these models, this thesis integrates detailed geological mapping, structural analysis, macrostructural observations, and in situ white mica Rb-Sr geochronology across the CB-CBU contact and associated deformation zones. Emphasis is placed on the relationships among foliation development, folding, shear zone evolution, and strain localization within both units. By integrating structural observations with new geochronological constraints, this study assesses whether structures previously attributed to Miocene extension instead reflect a more complex history involving structural inheritance and polyphase deformation. Ultimately, the

results are used to refine the tectonic evolution of Ios, reassess the significance of the South Cyclades Shear Zone, and evaluate the broader applicability of the MCC framework in regions affected by prolonged deformation histories.

Tectonic setting

Geology of the Cycladic Islands

The Cycladic Islands, located in the Aegean Sea of Greece, are part of the Hellenides orogenic belt, resulting from the convergence of the African and Eurasian tectonic plates and intervening crustal fragments (Bonneau, 1984; Jolivet and Faccenna, 2000; Jolivet and Brun, 2010; Ring et al., 2010; Roche et al., 2016; Glodny et al., 2022). The Attic-Cycladic complex exposed in the Cyclades consists of four distinct tectonometamorphic units: (1) The uppermost unit consists of Late Cretaceous and Paleocene crystalline rocks, which escaped Alpine high-pressure metamorphism (Katzir et al., 1996; Martha et al., 2016); and (2) the Cycladic Blueschist Unit (CBU) that underwent Alpine high-pressure/low-temperature (HP/LT) metamorphism at blueschist to eclogite facies conditions during the Eocene. The CBU consists of metabasites, schists and undifferentiated marble units (Avigad and Garfunkel, 1989; Ring et al., 2001; Brocker et al., 2013; Roche et al., 2016; Flansburg et al., 2019), and is the metamorphosed equivalent of the Pindos Unit, which was deposited in the Paleocene-Eocene Pindos Ocean prior to Hellenic collision (Papanikolaou, 1987; Jolivet and Brun, 2010). The CBU can be broadly subdivided into two discrete nappes, the lower Cycladic nappe and upper Cycladic nappe based on recorded temperatures of $<450^{\circ}\text{C}$ and $>500^{\circ}\text{C}$ and peak pressures of 10 kbar and 20 kbar, respectively (Grasemann et al., 2018). The CBU is underlain by (3) the structurally lower nappes of the Cycladic Basement (CB) and (4) the upper Basal Unit (Jolivet

and Brun, 2010; Ring et al., 2010). The CB consists of late Paleozoic I-type calc-alkaline and meta-aluminous granitoids that intruded metasedimentary host rocks (e.g., Huet et al., 2009; Augier et al., 2015).

Widespread syn- to post-orogenic extension throughout the Aegean was due to slab rollback and trench retreat of the African plate. This resulted in crustal thinning and the development of metamorphic core complexes, which facilitated the exhumation of HP/LT rocks to shallow crustal levels during the Oligo-Miocene (Lister et al., 1984; Jolivet and Brun, 2010; Jolivet and Brun., 2010; Grasemann et al., 2012). Across the Cyclades, exhumation was accompanied by a pervasive greenschist facies deformation overprint that constitutes the dominant metamorphic signature associated with extension (Baldwin and Lister, 1998; Forster and Lister, 2005; Wolfe et al., 2023). The exhumation history of the Cycladic Blueschist Unit and Cycladic Basement has therefore traditionally been interpreted within a Cordilleran-style MCC framework involving large-scale low-angle extensional detachments (Jolivet and Brun, 2010). Regionally, extension was accommodated by two major detachment systems: the North Cycladic Detachment System (NCDS) and the West Cycladic Detachment System (WCDS) to unroof the middle crust (Jolivet and Patriat, 1999; Mehl et al., 2005, 2007; Grasemann et al., 2012; Brun et al., 2016). These systems define distinct kinematic domains across the Cyclades. In the northern and central Cyclades, extension is predominantly top-to-north, whereas south-directed shear dominates within the western and southern Cyclades. Consistent with this regional pattern, southern Cycladic islands commonly preserve both N-S trending mineral and stretching lineations associated with top-to-south shear (van der Maar, 1980; Jolivet and Brun, 2010; Grasemann et al., 2012; Schneider et al., 2018). For example, on Santorini, the dominant N-S trending lineation is expressed by mineral lineations, fold axes, and intersection lineations

between the pervasive foliation and later crenulation is consistently associated with top-to-south kinematic indicators (van der Maar, 1980; Schneider et al., 2018). These observations suggest that a coherent south-directed transport within an extensional regime operated across much of the southern Cyclades during unroofing. In contrast, Ios occupies a transitional position between the northern and southern Cycladic kinematic domains and preserves a more complex kinematic record. Previous studies have documented both top-to-north and top-to-south shear sense across the island, making it difficult to assign the island to either regional kinematic domain (Lister et al., 1984; Vandenberg and Lister, 1996; Huet et al., 2009; Ring et al., 2025; Tsourtis et al., 2025). To explain the complex structural relationships observed on Ios and even nearby Sikinos, which hosts the same CB-CBU contact, Lister et al. (1984) proposed the existence of the South Cyclades Shear Zone (SCSZ), a regional-scale extensional structure accommodating exhumation between the northern and southern Cycladic domains. Subsequent studies have therefore interpreted the CB-CBU contact as the trace of this shear zone. However, the extent to which deformation is localized within a single, continuous shear zone on Ios remains uncertain, particularly given evidence for multiple deformation phases, heterogeneous strain distribution and the presence of several discrete shear zones (Baldwin and Lister, 1998; Huet et al., 2009; Ring et al., 2025; Tsourtis et al., 2025).

Geology of Ios Island

Ios is one of the southernmost islands of the Cycladic archipelago, located in the central part of the Aegean Sea (Figure 1). The geology was first described by van der Maar (1980) and van der Maar and Jansen (1983) and was interpreted as a metamorphic dome (van der Maar, 1980) and subsequently as a metamorphic core complex (Lister et al., 1984). The island's

geology is characterized by two major lithotectonic complexes (Figure 2). The Cycladic Basement (CB) is composed of deformed Carboniferous granites (van der Maar, 1980; Flensburg et al., 2019) that intruded into metasedimentary host rocks, which is overlain by the Cycladic Blueschist Unit (CBU; van der Maar, 1980; van der Maar and Jansen, 1983; Huet et al., 2009; Poulaki et al., 2019). A metamorphic evolution has been proposed for both the CB and CBU that includes prograde blueschist facies, peak eclogite facies conditions, and retrograde greenschist facies metamorphism (van der Maar, 1980; Forster and Lister, 1999). Early work by Grutter (1993) reported pressure-temperature estimates to be 9-12 kbar and 450-500°C, and results by Perraki and Mpsokos (2001) suggest peak HP/LT conditions at 25 kbar and 540°C. Subsequent work on peak conditions for the CB are like those on Sikinos, at 11 kbar and 475°C (Gupta and Bickle, 2004). The most recent investigations by Wolfe et al. (2023) found that garnet in both the CB and CBU grew at pressures of 15-20 kbar and temperatures of 470-500°C, recording the minimum conditions of garnet growth. Notably, Wolfe et al. (2023) summarized that there is no evidence in the QuiG and ZiR results that the rocks of the blueschist hanging wall and basement experienced different metamorphic histories during subduction.

The overall structure of Ios appears as a dome cored by the CB and mantled by the CBU. Schistosity exhibits a concentric pattern, dipping away from the centre of the island, with dominant N-S lineations (Huet et al., 2009). The CBU-CB contact was first interpreted as an unconformable sequence (van der Maar, 1980), leading to the suggestion that the contact is a thrust that was active prior to, or during, the HP/LT event under syn-orogenic conditions (van der Maar, 1980). No kinematics were identified or proposed for this thrust, and the syn-orogenic hypothesis was abandoned after the description of Ios as a post-orogenic MCC (Lister et al., 1984). In that study, Lister et al. (1984) mapped a south-directed, crustal-scale, middle-to-upper

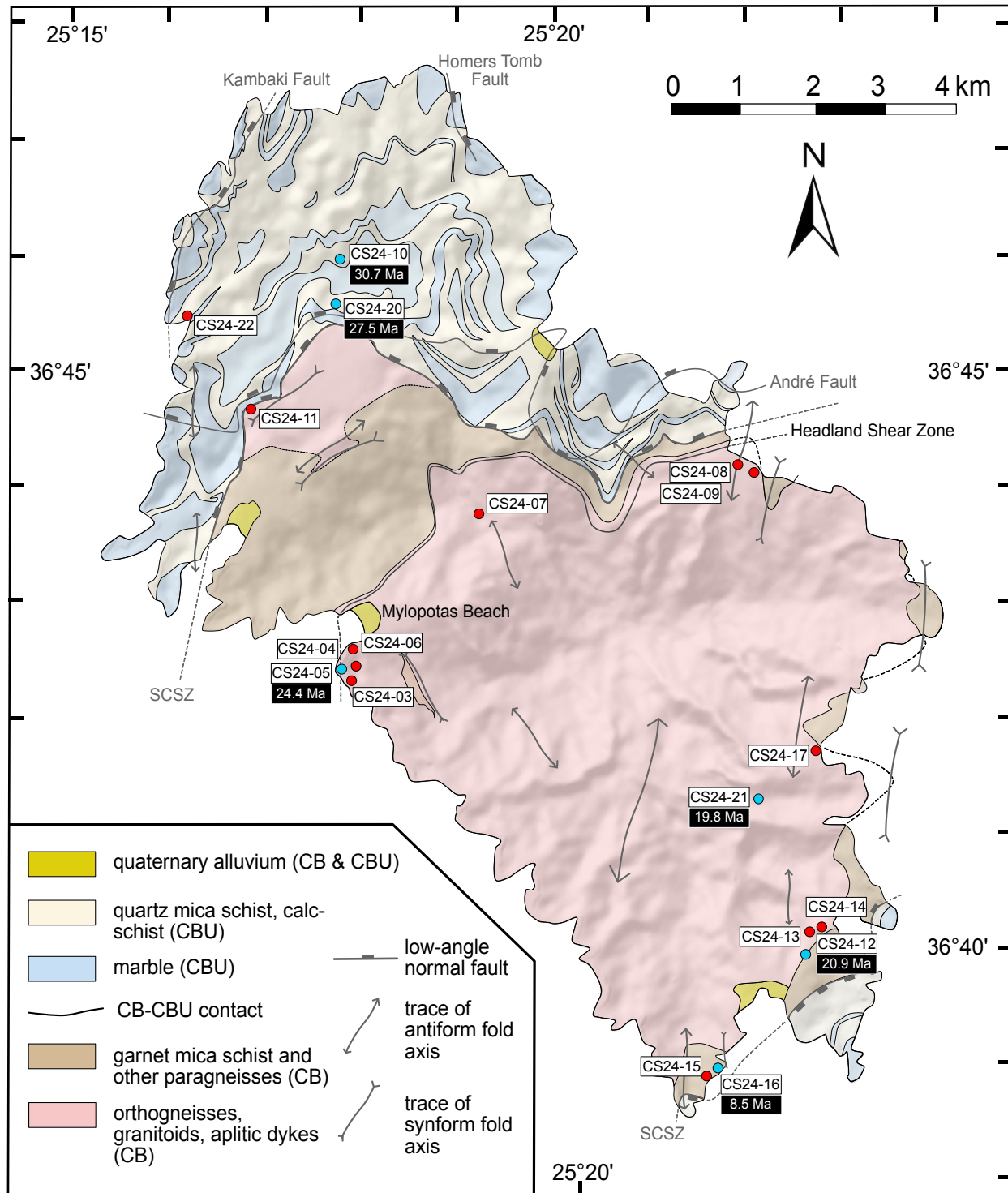


Figure 2. Geological map of Ios, Greece modified after Vandenberg and Lister (1996) and Huet et al. (2009). New white mica $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology sample locations are identified by blue circles. Other samples taken for microstructural analysis are identified by red circles (Table S1). Ios Detachment is coincident with SCSZ (South Cyclades Shear Zone).

greenschist facies shear zone at the contact between the CB-CBU, the so-called South Cycladic Shear Zone (SCZS). The contact has also been interpreted as a top-to-south extensional low-angle detachment fault (Ios Detachment; Forster and Lister, 1999; Mizera and Behrmann, 2016; Forster and Lister, 2019). Observations by Huet et al. (2009) and Flansburg et al. (2019) indicate that top-to-south kinematics pre-date top-to-north kinematics such that the original thrust juxtaposition of the two HP/LT units occurred during subduction, which was reactivated during extension (Huet et al., 2009; Augier et al., 2015). Within the CB's plutonic core and on northern Ios, a dominant pure shear strain geometry with both top-to-north and top-to-south kinematic indicators was noted (Huet et al., 2009; Mizera and Behrmann, 2016; Tsourtis et al., 2025). An apparent increase in both foliation intensity and simple shear components of deformation toward the CB-CBU contact have historically indicated that it operated as a south-directed shear zone (Vandenberg and Lister, 1996). Controversially, apatite U-Pb geochronology on shear zones within the CB and CBU shows that the high temperature (>500°C) mylonitic fabrics are pre-Cenozoic and therefore older than both Paleocene-Eocene subduction and Oligo-Miocene back-arc extension (Flansburg et al., 2026). That study suggested that mylonites exposed in the MCC are inherited shear zones rather than related directly to detachment faulting.

Several secondary shear zones and high-angle normal fault systems have been recognized on Ios (e.g., Headland Shear Zone, Andre Fault, Kambaki, Homers Tomb; Forster and Lister, 1999; Figure 2). These structures either juxtapose the basement and blueschist series or dissect the series and are identified by overprinting cataclasites and fault breccias (Forster and Lister, 1999). However, identifying these faults can be challenging, as they commonly juxtapose similar lithologies, while multiple generations of deformation have produced overprinting fabrics and

folds that may obscure the original fault relationships. For example, the André Fault is a high-angle brittle fault, containing cataclastic gouge, which overprints the CBU-CB contact, and juxtaposes grey marble bands against cream-coloured marbles, and in some locations incises into the basement across the mapped Ios Detachment (Forster and Lister, 1999). The youngest faults have been suggested to have formed during late-stage west-directed extension, (Kambaki Fault, Homers Tomb Fault; Forster and Lister, 1999). The top-to-north Headland Shear Zone that was mapped on the western coast of the island (Forster and Lister, 1999; Thomson et al., 2009) marks the contact of the garnet-mica schist with the augen gneiss core, occurring as intensely developed fabrics. These overprinting structures reflect a protracted deformation history on Ios.

Numerous geochronological studies on Ios provide a well-constrained temporal framework for its tectonometamorphic evolution. These geochronological datasets and their interpretations are compiled in Table S4. The oldest event recorded is the intrusion of the Cycladic Basement granitoids at c. 500 Ma, based on whole rock Rb-Sr, mica K-Ar, and zircon U-Pb data (Henjes-Kunst and Kreuzer, 1982; Flensburg et al., 2019). Subsequent basement recrystallization occurred during Variscan metamorphism that was dated at c. 300 Ma based on zircon U-Pb ages (Henjes-Kunst and Kreuzer, 1982; Flensburg et al., 2019). Post-Variscan cooling and potential partial resetting of isotopic systems are recorded in biotite K-Ar and Rb-Sr isochron ages ranging from 260-60 Ma (Henjes-Kunst and Kreuzer, 1982), as well as phengite and muscovite ages between 125-23 Ma (Andriessen et al., 1987). The dispersion of these ages is likely an indication of mixed age domains including primary crystallization, metamorphism, and cooling (Henjes-Kunst and Kreuzer, 1982). During the Alpine orogeny, both the CB and CBU experienced HP/LT metamorphism associated with subduction (Wolfe et al., 2023). Prograde metamorphism is constrained to c. 55 Ma based on garnet and zircon dates, with peak pressure

conditions attained at c. 40 Ma (Poulaki et al., 2019; Peillod et al., 2021). Subsequent deformation within the subduction channel likely involved significant ductile shearing and folding during exhumation, although direct geochronological constraints on these structures remain ambiguous and are typically inferred to lie between peak metamorphism and shallow crustal cooling.

Exhumation of the high-pressure units into the middle to upper crust is constrained by low temperature geochronology. Thomson et al. (2009) reported apatite fission track ages of 15-8 Ma from both the CB and CBU, indicating contemporaneous cooling and exhumation of these two units during the Miocene. This stage is widely associated with extensional tectonics in the Aegean, including greenschist facies overprinting, continued ductile deformation transitioning into the brittle regime, and the development of the low-angle normal fault systems (e.g., Jolivet and Brun., 2010; Ring et al., 2010; Grasemann et al., 2012). More recent zircon and apatite (U-Th)/He geochronology from Ios and Sikinos also demonstrates that both the CB and CBU experienced indistinguishable late-stage cooling histories and were exhumed together as a coherent block during Miocene extension rather than being tectonically juxtaposed at the time (Flansburg et al., 2023). These low temperature results imply that the CB-CBU contact was already established prior to Miocene extension and underwent little to no significant reactivation during final exhumation. Brittle faulting and final exhumation to the surface are generally interpreted to have occurred during the Late Miocene to Pliocene, marking the final stages of tectonic evolution within the broader framework of Aegean extension (e.g., Jolivet et al., 2013).

Methodology

Structural analysis

On Ios island, geological mapping was conducted to investigate the structural relationship between the CB and CBU across their mapped contact and to establish the relative timing of shearing and folding within both units. Emphasis was placed on documenting cross-cutting and overprinting relationships between shear-related fabrics (e.g., S–C fabrics) and fold-related structures (e.g., axial-planar cleavage). This mapping builds upon previous structural and geological investigations of Ios (Figure 2; e.g., van der Maar and Jansen, 1983; Vandenberg and Lister, 1996; Huet et al., 2009; Flansburg et al., 2019, 2026; Ring et al., 2025). The geological map was constructed by integrating existing maps (Figure 2; Huet et al., 2009; Thomson et al., 2009; Vandenberg and Lister, 1996) with new field observations. Structural data was analyzed using Stereonet software with foliation, lineation, and fold axes measurements plotted on lower hemisphere, equal-area stereographic projections. Field observations were complemented by microstructural analysis of representative samples, with a complete summary of microstructural observations provided in Table S1 in the supplementary information.

Mineral Chemical analysis and $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology

To perform a petrological analysis of the samples, a total of 18 oriented thin sections were made and examined under an optical microscope. Thin sections were prepared perpendicular to the dominant foliation and parallel to mineral stretching lineation. Where applicable, thin sections were oriented to the dominant N-S orientation to facilitate the identification of N-S shear-sense indicators and characterization of deformation microstructures. Mica geochemical analysis was conducted on six samples which were also dated using in-situ $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology to identify the species of white mica present within the samples.

Sample selection criteria were based on the condition of mica grains, with ideal grains containing little alteration, inclusions, and kinks. As well, ideal samples contained mica grains within a preferred orientation, as well as grains that had been folded to further constrain timing of these deformational events. Variations in major element composition were used to distinguish between different white mica populations (e.g., muscovite vs. phengite), allowing compositional differences to be linked to more specific metamorphic conditions and deformation events recorded. The in-situ approach allowed for deliberate targeting of white mica to compare possible deformation relationships within the CBU, CB, and HSZ. Two samples were selected from the CBU, and four were selected from the CB, with one of these samples from within the Headland Shear Zone.

The mineral chemistry of white mica was analyzed via electron probe microanalyzer (EPMA) performed at the University of Ottawa using a JEOL JXA-8230 SuperProbe. Mica was analyzed using a beam diameter of 10 μm with an accelerating voltage of 15 keV and beam current of 20 nA. Dwell times of 10 s were used for X-ray peak positions and 5s for background positions. Wavelength dispersive spectroscopy (WDS) acquired quantitative chemical data for the major and minor elements Si, Al, Ca, Mg, Fe, K, Na, Ti, Cr, Mn, Cl, and F. The laboratory standards used were sanidine (Si, Al, K), diopside (Ca, Mg), hematite (Fe), albite (Na), rutile (Ti), chromite (Cr), and tephroite (Mn). White mica compositions were recalculated manually on the basis of 11 O, following the methodology of Vidal and Parra (2000) and Parra et al. (2002), accepting only analyses with weight percent oxide sums between 92-96% and with $<0.5 \text{ wt\% TiO}_2 + \text{MnO} + \text{CaO}$. Recalculations assumed 11 oxygens and calculated molar fractions for seven endmembers (Mg- and Fe-Al celadonite, muscovite, annite, phlogopite, paragonite,

pyrophyllite). All mineral chemical data and associated formula recalculations are found in Table S2 in the supplementary information.

The same polished sections were used for in-situ laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) $^{87}\text{Rb}/^{87}\text{Sr}$ geochronology. Procedures follow Zack and Hogmalm (2016) and Hogmalm et al. (2017) using an Agilent 8900 triple-quadrupole inductively coupled plasma mass spectrometer equipped with a reaction cell paired to an ESL 193 Excimer laser with a TwoVol3 ablation cell in the Fipke Laboratory for Trace Element Research at University of British Columbia-Okanagan (Kelowna, Canada). The analyses followed the basic procedures outlined in Larson et al. (2025) with the white mica ablated using a 50 μm diameter laser spot, a repetition rate of 10 Hz and a laser fluence of 4 J/cm².

Analyses of secondary reference materials include an in-house white mica MA1 (c. 350 Ma, A. Camacho, unpublished data), LaPosta (c. 91.6 Ma, Zack and Hogmalm, 2016), white mica 1B (c. 990 ± 5 Ma, Camacho et al., 2012), white mica 1O (c. 986 ± 5 Ma, Camacho et al., 2012), a nano-powdered biotite, Mica-Fe (305.4 ± 2.0 Ma, Rösel and Zack, 2022), and a nano-powered tablet, Mica-Mg (c. 519 ± 7 Ma, Hogmalm et al., 2017). The dates of the reference material analyses overlap within error of those expected (364 ± 11 Ma, 96 ± 4 Ma, 984 ± 23 Ma, 985 ± 7.2 Ma, 317 ± 33 Ma, and 501 ± 20 Ma, respectively). Results and reference material calculations are reported in Table S3.1 and S3.2 in the supplementary information. Isochron calculations excluded analyses with high uncertainty, using a >30% (2 s.e. of the mean) cut-off that resulted in no data exclusion. Data processing and visualization were performed using the online version of the IsoPlotR package (Vermeesch, 2018).

Four samples were collected from the Cycladic Basement, within both the orthogneiss and garnet-mica schist lithologies. White mica across all samples is both texturally and

chemically homogeneous, as confirmed through petrographic observations and compositional analysis. Analytical spots were preferentially selected on grains defining the dominant foliation, as well as on grains oriented obliquely to it to assess potential relationships between deformation fabric and isotopic systematics. In the Rb-Sr dataset, phases interpreted to contain elevated initial Sr were excluded from isochron construction to minimize the influence of non-radiogenic Sr on age calculations. Uncertainties were reported at 2σ (standard deviation; Table S3.1 and S3.2).

Data filtering was conservative, with fewer than 10% of analytical spots removed, and only in cases where anomalous elemental compositions or clear outliers suggested mixed phases or analytical artefacts. This approach ensures that the calculated ages are robust and representative of the targeted mineral population.

Field and microstructural observations

Cycladic Basement

Within the Cycladic Basement, the earliest identifiable fabric is a schistose S_2 foliation, with the planes of S_2 commonly dipping away from the centre of the island, and in some more detailed mapped sections, the strike distribution shows a semi-concentric pattern (Figure 3a). Along the foliation plane, S_2 is associated with a dominant N-S stretching mineral lineation (L_1), which is oriented parallel to the axes of outcrop-to-map-scale isoclinal folds, and is defined by quartz rods, fibrous phyllosilicates growing along schistosity planes, prismatic K-feldspar, or alignment of pressure shadows adjacent to garnet porphyroclasts. The pervasive S_2 foliation is defined by tabular white mica (250-500 μm) that comprises up to 50% of the rock volume

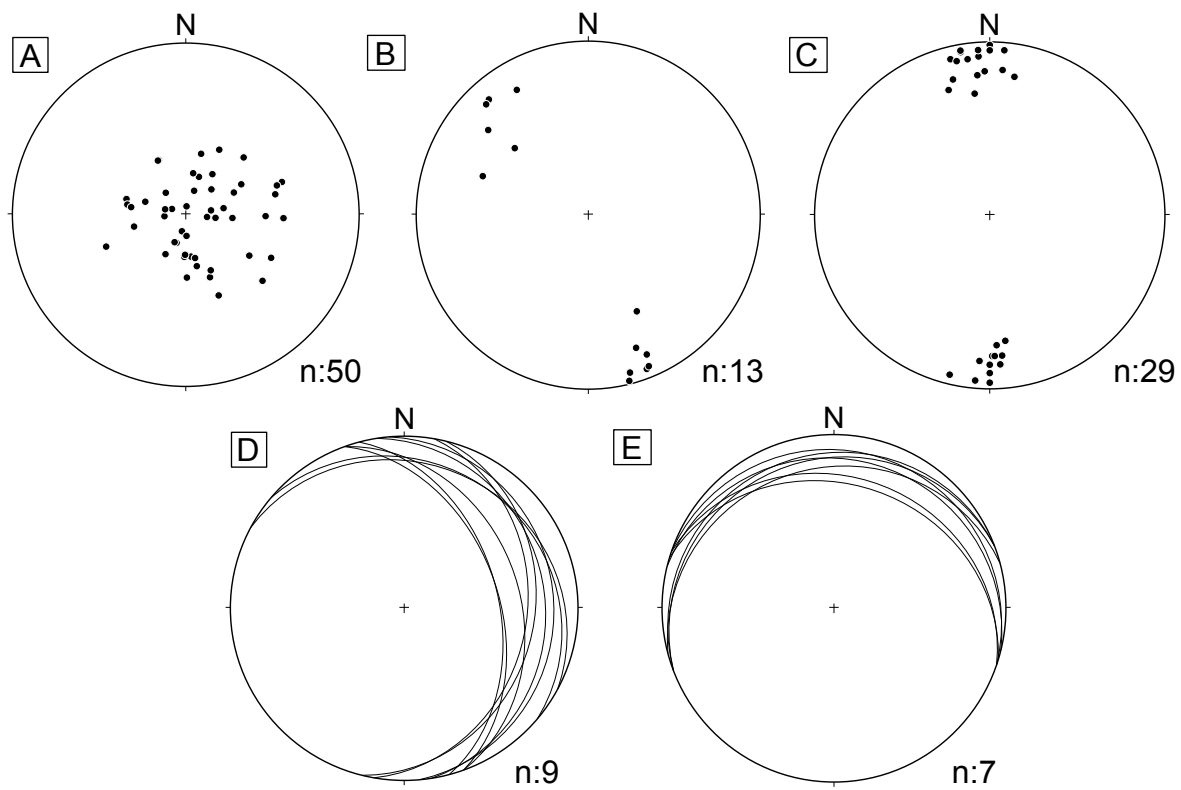


Figure 3. Structural measurements on Ios within all lithologies. (a) poles to foliation (schistosity), (b) NW-SE stretching lineations, (c) N-S stretching lineations, (d) NE-dipping axial planes, (e) N-dipping axial planes.

(Figure 4a, b, c). In thin section the white mica exhibits bird's-eye extinction and a tabular habit (Figure 4b). The white mica appears to be fully recrystallized, resulting in two generations of white mica: a generation of larger, subhedral grains defining the S_2 foliation, and a second generation of smaller (100-500 μm) grains oriented at oblique angles to the N-S dominant foliation (Figure 4b). Some grains exhibit micro-folding or are wrapping around pre- to syn-kinematic quartz, feldspar, and garnets (Figure 4d). Quartz (50-250 μm) in the garnet-mica schists comprises 25-40% of the rock volume, and displays undulous extinction, with extensive dynamic recrystallization through sub-grain development (Figure 4e). One sample within the garnet-mica schist exhibits grain boundary migration within mylonitic quartz veins. Pressure solution seams are also common, where darker anastomosing bands exist at grain boundaries to the white mica and which preferentially infilled hinge zones of microfolds (Figure 4f).

Folding within the mica schist is widespread. Earlier deformation is characterized by tight to isoclinal recumbent folds (F_1) that are commonly southwest-vergent and possess fold axes that trend NW-SE to NNW-SSE (Figure 3d). Similar recumbent folds with axes parallel to the mineral stretching lineation were described by Huet et al. (2009), and attributed the progressive fold tightening, limb attenuation, and transposition to be responsible for development of the pervasive schistosity. Local asymmetric folds have been documented near the CB-CBU contact, with axes subparallel to the stretching lineation (Figure 4g; Forster and Lister, 1999; Huet et al., 2009), although they are treated here as part of the same progressive deformation owing to their similar geometry and relative timing relationships. A younger generation of open folds (F_2) refold the earlier recumbent structures and is characterized by gently plunging, east-west-trending fold axes. These folds exhibit attenuated limbs and thickened hinges (Figure 3e; 4h, i). Although F_1 and F_2 appear to represent closely related phases of

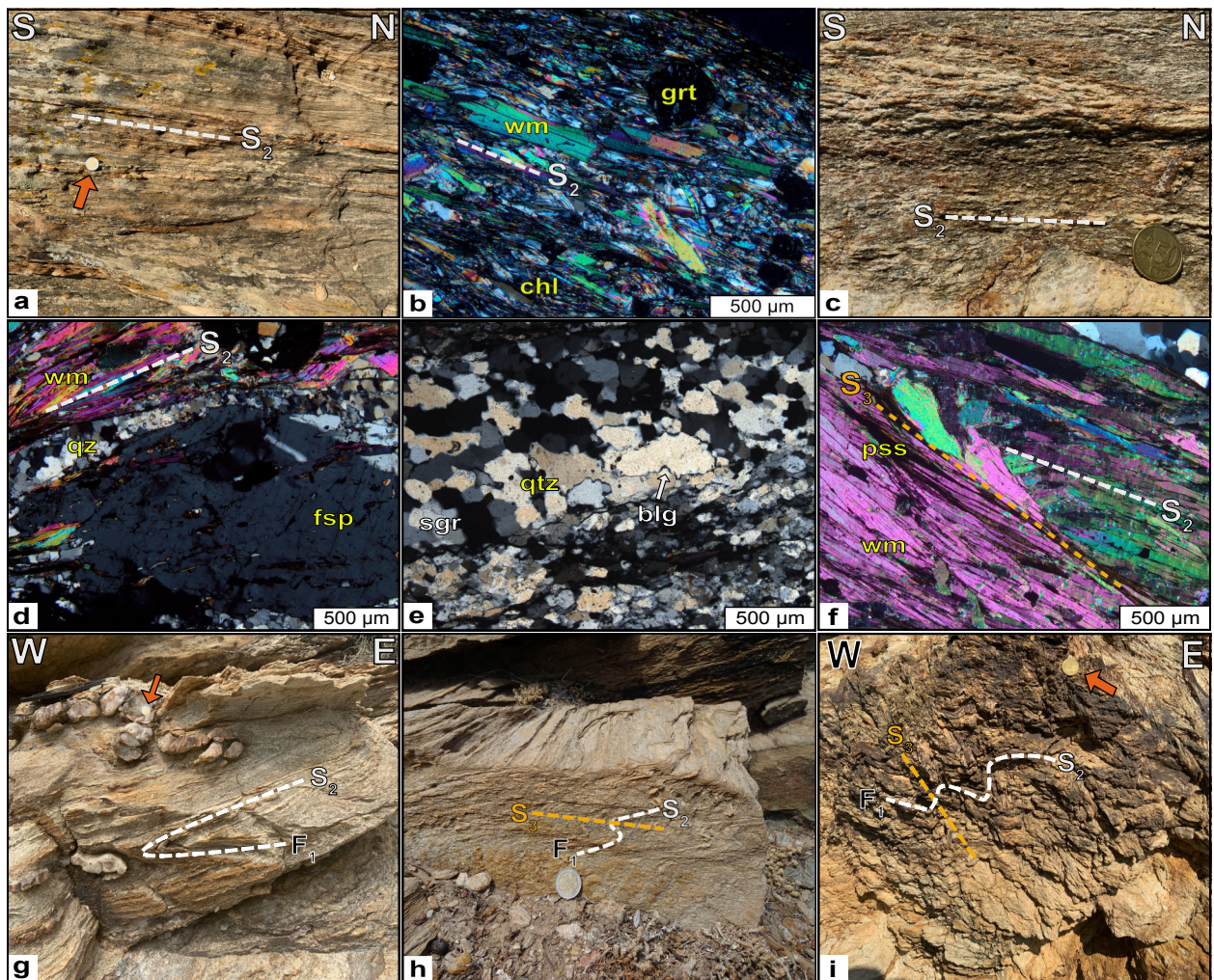


Figure 4. Field photographs and photomicrographs of the garnet mica schist within the Cycladic Basement. (a; E 347946 N 4063486) Grt-wm schist with aligned white mica defining the S_2 foliation (S_2 ; avg. orientation 020/45°) (b; E 353199 N 4056981) Photomicrograph (cross-polarized light) of a grt-wm schist from sample CS24-16, displaying tabular white mica defining the main foliation (S_2) and a potentially younger generation of white mica oriented oblique to the main fabric. Retrograde chlorite alters white mica grains. (c; E 347241 N 4063713) Field photograph of a wm schist exhibiting stretched quartz rods and white mica along the schistosity plane (S_2). (d; E 353830 N 4067255) Photomicrograph (cross-polarized light) of a mylonitized orthogneiss sample from the Headland Shear Zone (CS24-09). Aligned white mica (S_2) wraps around feldspar porphyroclasts, with recrystallized quartz occurring in the strain shadows of feldspar grains. Feldspar is fractured and is filled with white mica. (e; E 346543 N 4066453) Photomicrograph (cross-polarized light) of a grt-wm schist (CS24-04), with quartz deforming by subgrain rotation and displaying bulging and locally lobate grain boundaries. (f; E 348653 N 4063455) Photomicrograph (cross-polarized light) of a mylonitized wm schist from the Headland Shear Zone (CS24-05). Quartz grains display pressure solution seams along grain boundaries and cross-cutting axial planar cleavage (S_3 ; avg. orientation 050°/20°), highlighted by the dotted orange line. Pressure solution seams are commonly concentrated along cleavage planes. (g; E 345168 N 4065760) Field photograph of tight/isoclinal recumbent folding in the mica schist (F_1), which folds the main schistosity (S_2). (h; E 353236 N 4056921) Field photograph of folded S_2 schistosity within the host rock and the resultant axial planar cleavage (S_3) associated with later folding. (i; E 354758 N 4059086) Field photograph showing refolding of F_1 and the development of a resultant axial planar cleavage (S_3). Orange arrow indicates the location of the scale. Coin: 26 mm diameter; hammer: 30 cm long. wm: white mica; grt: garnet; chl: chlorite; qz: quartz; fsp: feldspar; sgr: subgrain rotation; blg: bulging; pss: pressure solution seams.

deformation rather than discrete tectonic events, they are distinguished and mapped separately based on their distinct structural characteristics in the field.

The intrusive unit within the CB is a variably deformed orthogneiss with a Hercynian granitic protolith (Figure 5a; van der Maar and Jansen, 1983; Vandenberg and Lister, 1996; Flansburg et al., 2019). Like the garnet-mica schist, a N-S stretching lineation (L_1) within the orthogneiss is defined by elongation of quartz and feldspar and alignment of elongated phyllosilicates. The earliest recognizable fabric in the orthogneiss is a penetrative anastomosing gneissic foliation defined by white mica and fine grained dynamically recrystallized quartz and feldspar porphyroclasts (S_2 ; foliation domains are 0.5-3 mm wide; Figure 5a, b). The spacing between folial domains is dependent on the size of feldspar porphyroclasts (1 mm-3 cm). The S_2 schistosity within the host rock mica schist is locally crosscut by the orthogneiss unit, which contains a penetrative gneissic foliation (S_2 ; Figure 5c, d). The orthogneiss S_2 is subparallel to S_2 within the mica schist unit, and together they are deformed by subsequent events (Figure 5d). Although the intrusion clearly post-dates the schistose fabric of the mica schist, the age of the foliation within the orthogneiss relative to S_2 in the schist is uncertain and may be either synchronous with, or younger than deformation responsible for the S_2 schistosity development (Figure 5e). On a map scale, lenses of mica schist are folded within the orthogneiss, and schistosity orientation indicates variable dip directions across individual lenses, consistent with folding of schist layers, as seen by fold traces on a map scale (Figure 2). Folding of aplitic dykes within the Cycladic Basement also occurs, indicating the intrusions were emplaced before folding (Figure 5f). The lack of shearing along the intrusive contacts suggests the dyke and orthogneiss were likely folded together. At least two generations of folding (F_1 and F_2) were identified within the orthogneiss, most clearly exposed near its contact with the garnet-mica

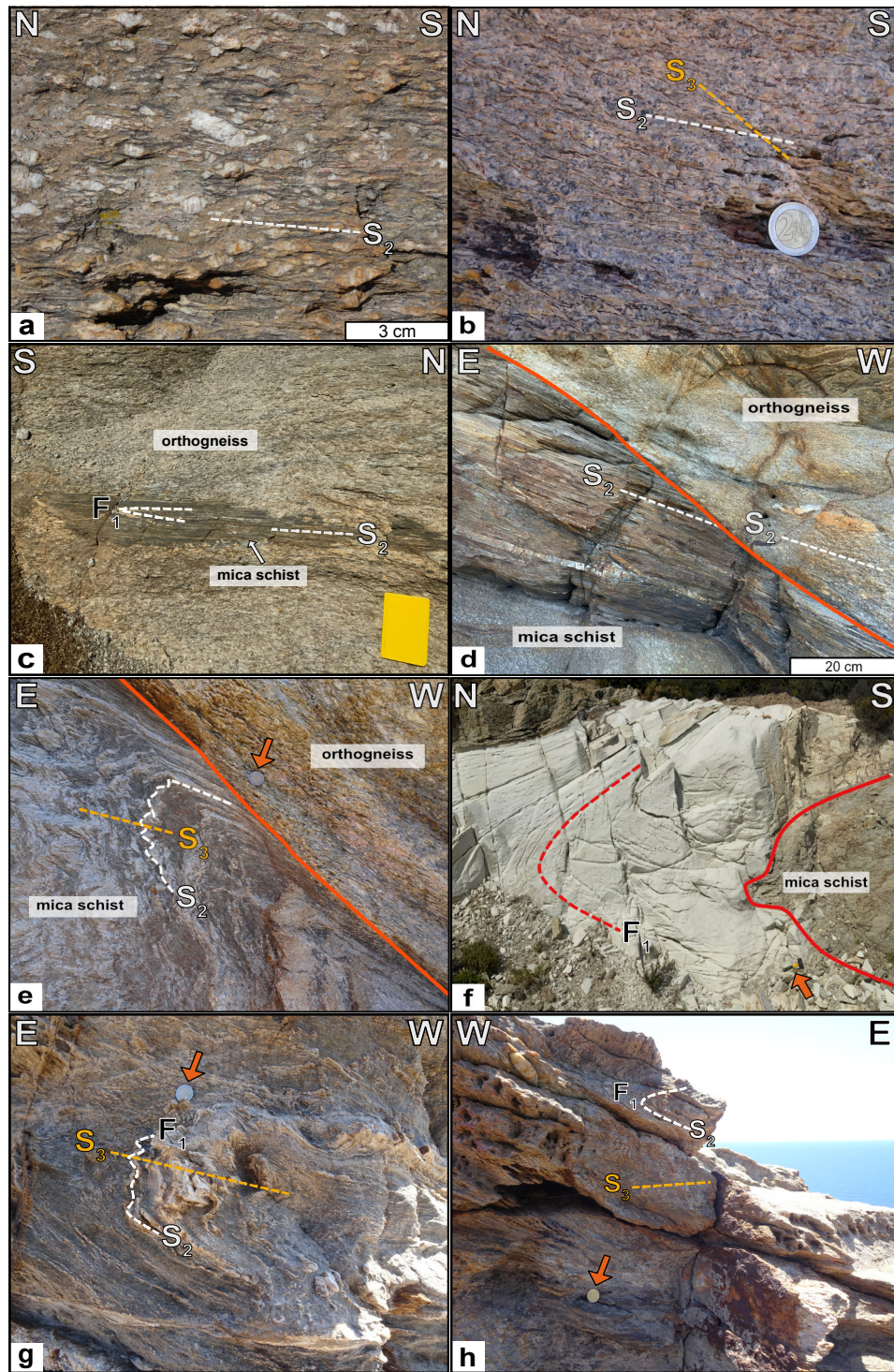


Figure 5. Field photos of the orthogneiss lithology within the Cycladic Basement. (a; E 347946 N 4063486) Orthogneiss with no mylonitization, with 1-4 cm elongate feldspar porphyroclasts defining a weak S_2 gneissic foliation. (b; E 354800 N 4059075) Orthogneiss with a pre-existing foliation (S_2 ; avg. orientation $178^\circ/40^\circ$) and an axial plane cleavage due to folding (S_3 ; avg. orientation $030^\circ/26^\circ$). (c; E 347570 N 4063609) wm schist xenolith within the orthogneiss which preserves a pre-intrusive mylonitic foliation (S_2) with quartz veining folded parallel to the stretching lineation. (d; E 347579 N 4064030). Sharp contact between the orthogneiss and wm schist near Mylopotas beach, pre-existing (S_2) foliation in wm schist and “subsequent” foliation (S_3) in the orthogneiss. (e; E 347408 N 4064176 h; E 347582 N 4064016) Refolding of mylonitic foliation within the mica schist unit (S_2), recording a folding event before the intrusion of the granite displaying a planar gneissic foliation (S_2). (f; E 352526 N 4062250) Folded contact of aplitic dyke and wm schist displaying lack of shearing at the contact. (g; E 348334 N 4063778) Contact of mica schist and orthogneiss, with post-intrusion folding of the mylonitic foliation. (h; E 347514 N 4063615) Folded S_2 gneissic foliation within the orthogneiss and resultant axial planar cleavage (S_3).

schist (Figure 5d). The earlier F_1 generation is characterized by tight to isoclinal, recumbent folds with NW-SE to NNW-SSE-trending fold axes, comparable in orientation to those observed in the mica schist and broadly parallel to its S_2 foliation (Figure 3d). Subsequent F_2 folding of the S_2 foliation within the orthogneiss produced an axial-planar crenulation cleavage (S_3 ; Figure 5d, e, g, h).

The geometric relationship between the dominant foliation (S_2) and axial-planar cleavage (S_3) provides a useful criterion for identifying and distinguishing the limbs of SW-vergent folds in both the orthogneiss and mica schist. Where S_2 within the mica schist is mylonitic, this fabric is itself folded and overprinted by S_3 , indicating that development of the mylonitic foliation preceded at least one subsequent folding event associated with the formation of the axial-planar cleavage. In outcrops where both fabrics are preserved, the foliation (S_2) is steeper than axial planar cleavage (S_3) in the upper limb (Figure 6a, b) and axial planar cleavage (S_3) is steeper than foliation (S_2) in the lower limb (Figure 6b). Refraction of S_3 across the folded S_2 fabric is penetrative within both the upper and lower limbs of the folds (Figure 6c, d). In Figure 6d, there is also evidence of S_3 being slightly steeper than S_2 on the upper limb of the fold, a relationship that is also viewed elsewhere on Ios and indicates some local variability in the orientation of the two fabrics. Locally, shear sense indicators are preserved within these folded fabrics and record opposing apparent kinematics, with their orientations varying systematically between fold limbs.

The S_2 foliation domains of white mica of the orthogneiss are 100-250 μm wide, and micas exhibit bird's eye extinction and alteration rims (Figure 7a). Grain shape varies from tabular to subhedral where grains are recrystallized within bundles, adjacent to porphyroclasts. A locally developed oblique foliation of white mica is common in the orthogneiss, with 0.2-2 mm long grains oriented oblique to the main gneissic foliation (Figure 7a). Pressure solution seams

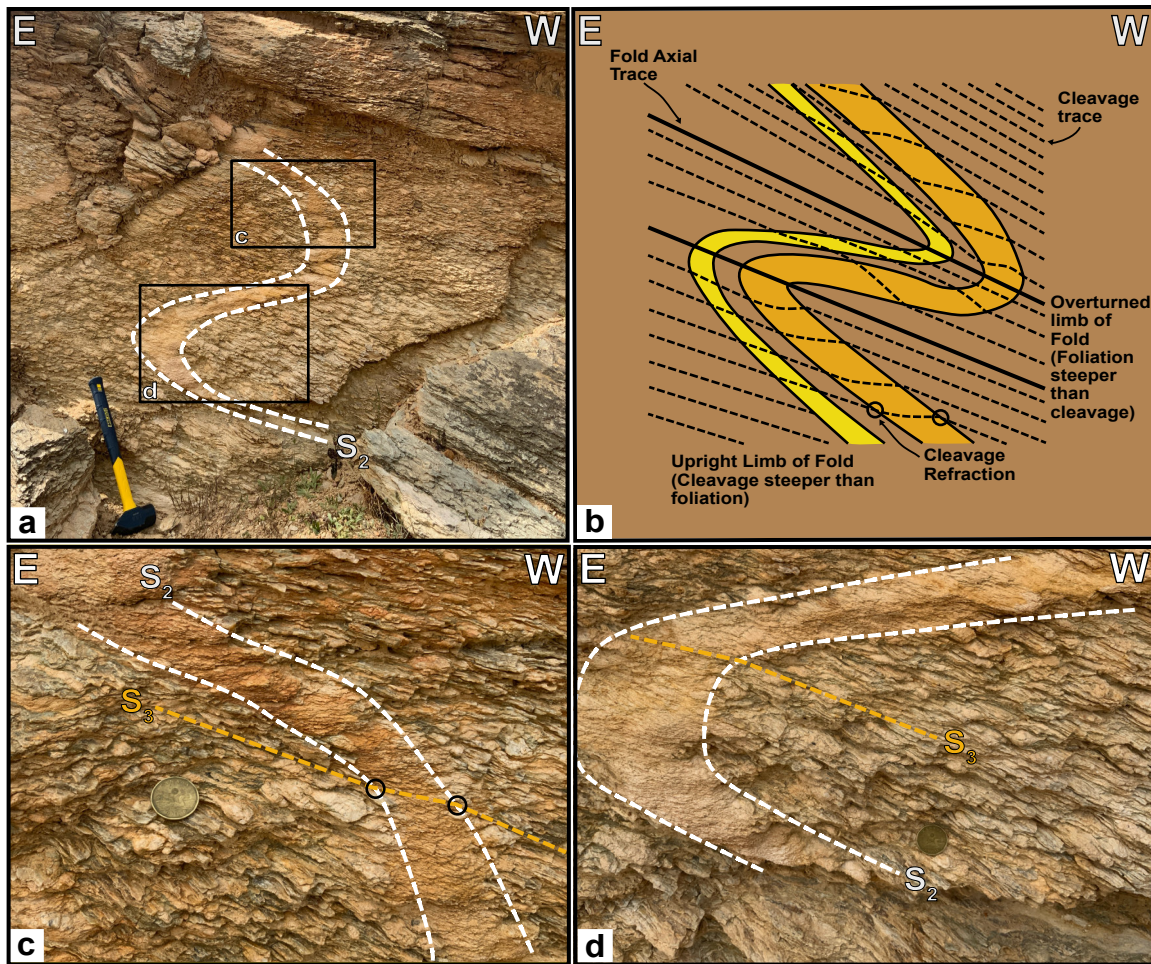


Figure 6. Transect of a fold to compare foliation vs cleavage relationships in the Cycladic Basement. (a; E 350088 N 4066013) Overview of S_2 defining a z-type fold, with black boxes indicating locations of enlarged inset views. (b) Schematic of the apparent relationship of foliation and cleavage within the limbs of a fold, highlighting cleavage refraction. (c; E 350088 N 4066013) Upper limb of the fold, where foliation (S_2) is folded, and the axial planar cleavage (S_3) is refracted within the limb of the fold. (d; E 350088 N 4066013) lower limb of the fold, where foliation (S_2) is folded, and the axial planar cleavage (S_3) is refracted within the limb of the fold.

are common at mica boundaries (Figure 7b). Quartz microstructures are dominated by dynamic recrystallization, commonly exhibiting pressure solution at quartz grain boundaries and subgrain rotation like the mica schist, with some samples showing evidence for bulging and suturing (Figure 7c, d). In these samples, feldspar porphyroclasts (0.5-3 mm) are fractured and contain recrystallized ductile quartz within their strain shadows (Figure 7e). Locally, shear bands in more mylonitic samples exhibit higher temperature deformation mechanisms, with migrating grain boundaries (Figure 7f). Potassium feldspar exhibits microcline twinning where deformation has occurred against adjacent mineral grains, and white mica wraps these porphyroclasts (Figure 7d). In less deformed granitic orthogneiss samples, some of the plagioclase feldspar has been partially replaced by white mica (Figure 7e).

Kinematic indicators are widespread throughout the CB and have been extensively documented in previous studies. They occur in both outcrop- and thin section-scale observations. Mesoscopic structures include garnet and feldspar σ -clasts, S-C fabrics, asymmetric boudins, climbing quartz veins, and shear bands developed within garnet-mica schist and orthogneiss lithologies (Figure 8). Microstructural indicators include mica fish, anastomosing shear bands, pressure shadows and asymmetric porphyroclasts (Figure 8b, e). Both top-to-south and top-to-north shear sense indicators were documented in outcrop and are preserved across multiple lithologies (Figure 8b, f; Huet et al., 2009; Tsourtis et al., 2025). Previous studies have interpreted these relationships as evidence for multiple phases of shearing, however there is more ambiguity to these as new observations have noted that folding occurred post-shearing (Flansburg et al., 2026; this study).

In addition to the SCSZ, several faults have been mapped on Ios (Figure 2; Homer's Tomb, Kambaki Fault, André Fault, Coastal Fault system). Most faults are characterized by

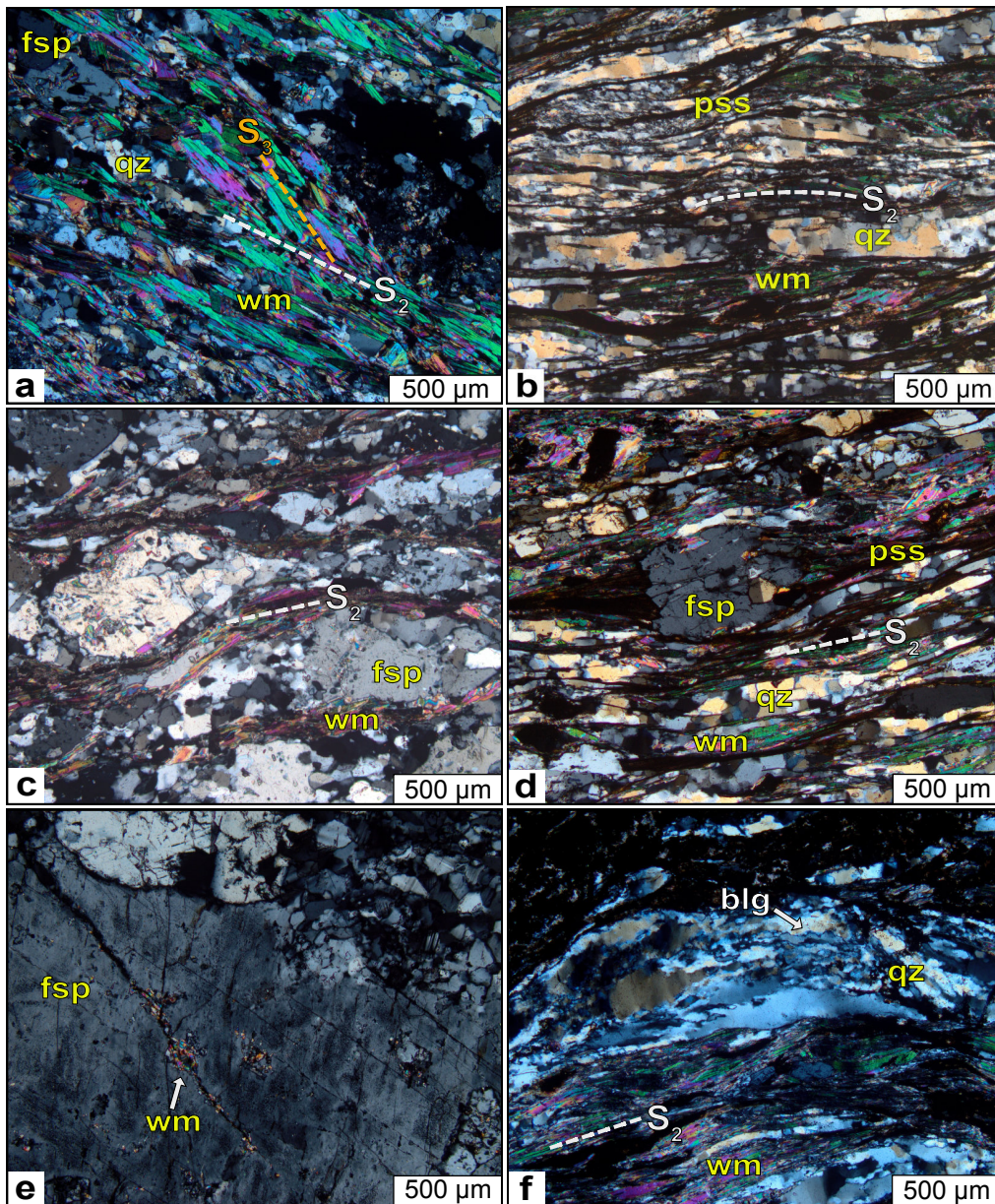


Figure 7. Petrographic (cross-polarized light) images of samples from the orthogneiss within the Cycladic Basement. (a; E 355140 N 4062096) White mica grains defining foliation (S_1) which was later folded and displays an axial planar cleavage (S_3) (CS24-21). (b; E 349721 N 4066776) Pressure solution seams at grain boundaries, exhibiting weak S_3 crenulation cleavage (CS24-07). (c; E 353840 N 4067213) Undulose white mica defining foliation, wrapping asymmetric feldspar phenocrysts (CS24-08). (d; E 349721 N 4066776) Quartz porphyroblasts with white mica defining foliation and wrapping grain. Quartz pressure solution seams at boundaries with white mica layers and within strain shadows (CS24-07). (e; E 354897 N 4058656) Feldspar phenocryst with brittle fractures infilled by recrystallized white mica. Recrystallized smaller feldspar grains with microcline twinning at grain boundaries (CS24-12). (f; E 354899 N 4058659) Mylonitized quartz vein in a localized shear band with fine-grained recrystallized quartz and a few medium sized grains displaying undulose extinction. Quartz grains exhibit bulging and irregular, lobate grain boundaries (CS24-14). See Table S1 for locations of samples. wm; white mica, fsp; feldspar, qz; quartz, pss; pressure solution seam, blg; bulging

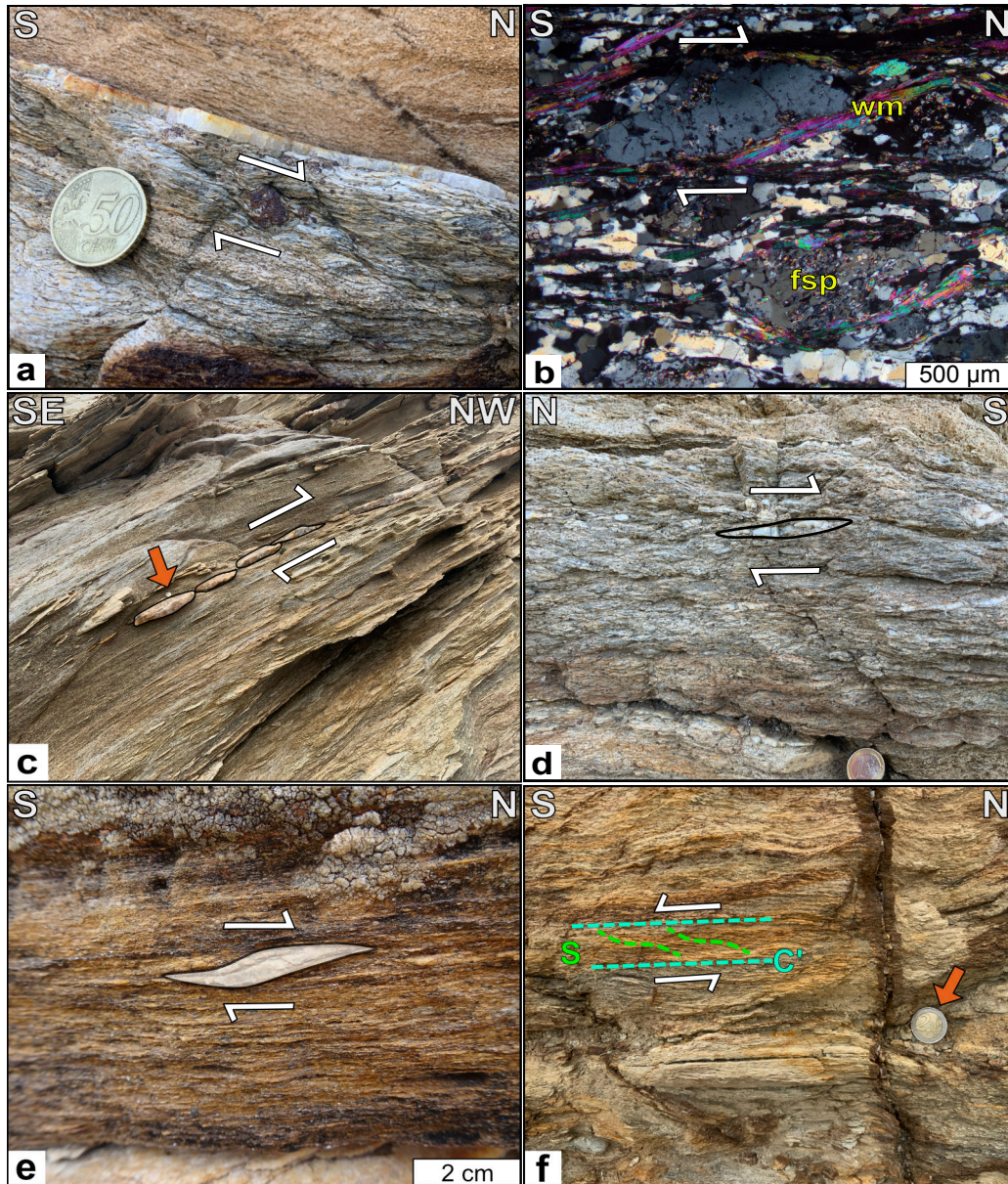


Figure 8. Shear sense indicators within the Cycladic Basement. (a; E 354758 N 4059086) Asymmetric garnet porphyroblast within mica schist denoting top-to-north. (b; E 355140 N 4062096) Orthogneiss from the central Cycladic Basement, feldspar porphyroclasts with irregular grain boundaries and mineral inclusions. White mica defining foliation wraps the grain and recrystallized quartz along grain boundary (CS24-21). (c; E 353403 N 4057088) Climbing pinch and swell quartz veins within mica schist crosscutting S_1 foliation. (d; E 354758 N 4059086) Sigmoid quartz vein. (e; E 354800 N 4059075) Top-to-north quartz sigmoid within the mica schist unit. (f; E 345801 N 4067772) S-C structures within mica schist denoting top-to-south. See Table S1 for sample locations.

narrow zones of brittle deformation, including localized fracturing, fault brecciation, and sharp truncation of pre-existing foliations. Where identifiable markers are preserved, offsets are typically on the order of metres, suggesting relatively limited displacement. These structures crosscut earlier ductile fabrics, representing late-stage brittle deformation. On the other hand, the Headland Shear Zone (HSZ) represents a late yet high strain structure within the mica schist unit of the Cycladic Basement, overprinting earlier ductile fabrics including the axial planar cleavage. The fault trace was originally mapped north of Milopotas Beach (Vandenberg and Lister, 1996) and extended slightly east, but new field observations extend the shear zone continuously to the east, following the contact of the mica schist lens below the CB-CBU contact (Figure 2). This structural position is consistent with previous descriptions of localized high strain zones developed along lithological contacts within the Cycladic Basement, where competency contrasts promote strain localization (e.g., Lister and Raouzaïos, 1996; Huet et al., 2009). The HSZ is characterized by top-to-north kinematic indicators, including climbing feldspars, quartz σ -type porphyroclasts, shear bands, and foliation boudinage. These structures post-date the earlier mylonitic foliation and axial planar crenulation cleavage (Figure 9a, b). Deformation within the HSZ is associated with finer grain sizes than the host rock. This overprinting relationship is documented across m- to mm-scales where older top-to-south fabrics are preserved as relict foliations that are overprinted by younger top-to-north shear bands, indicating progressive strain localization during deformation. Foliation boudinage occurs within the HSZ, and numerous overturned west-vergent inclined folds have been variably overprinted by the high strain zone (Figure 9c, d). Field observations demonstrate that the HSZ forms a laterally continuous high strain corridor extending eastward from its previously mapped extent and is characterized by pervasive overprinting of earlier deformation fabrics.

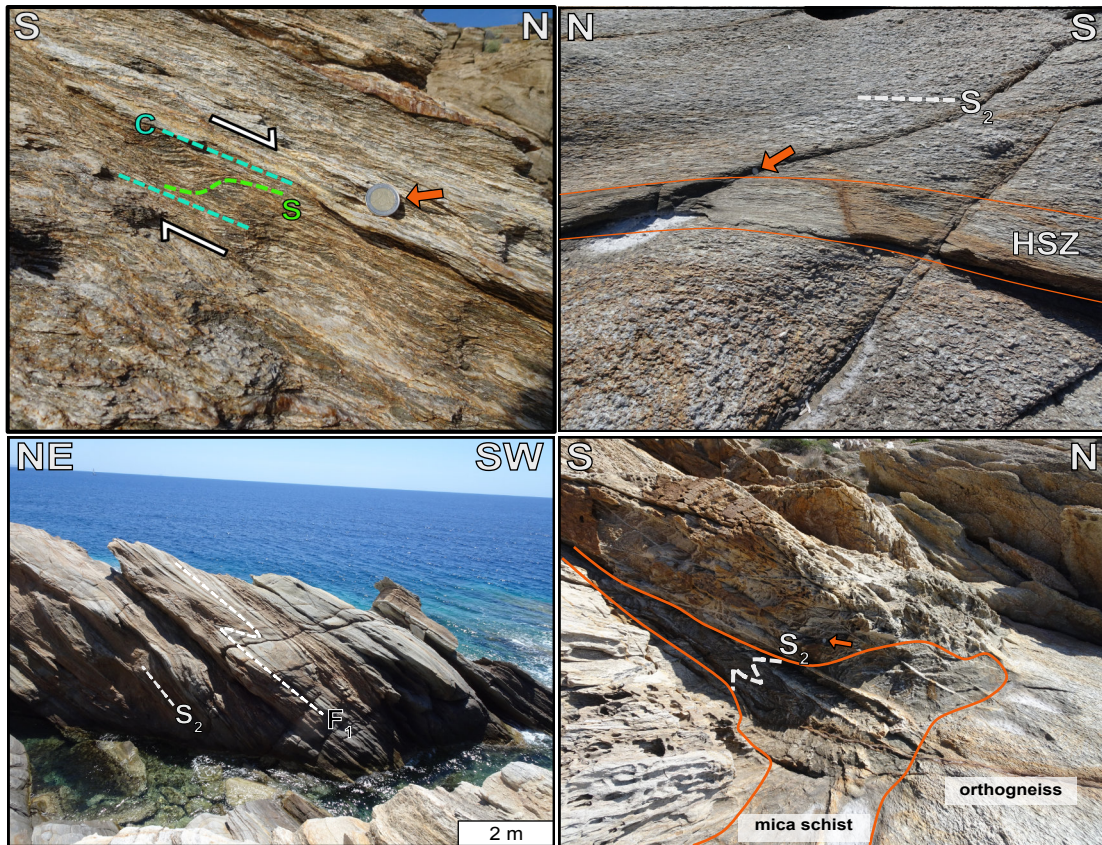


Figure 9. Photos of the Headland Shear Zone (HSZ) on eastern Ios. (a; E 347261 N 4063695) Top-to-north S-C structure crosscutting existing foliation (S_2) at a shallow angle. (b; E 347300 N 4063687) Visible very-fine grain sizes within the shear zone (0.5 m width), contrasted with the large-grained orthogneiss. (c; E 347245 N 4063666) West-vergent isoclinal fold (F_1) within the grain size reduced, sheared garnet-mica schist, folding the S_2 foliation (d; E 347231 N 4063690) Folding associated with the north-directed HSZ and faulting juxtaposing the garnet-mica schist against the mylonitic orthogneiss.

Cycladic Blueschist Unit

The earliest identifiable fabric within the undifferentiated schists of the CBU is a foliation defined by aligned glaucophane and white mica, sharing the domal structure of the CB (S_2 ; Figure 3a; 10a, b). In several outcrops, more than one generation of lineation appears to be preserved. The dominant N-S lineation (L_1) is well developed and associated with the main foliation (S_2), and local secondary lineations overprint or intersect L_1 , which were difficult to identify in the field, but similar observations have been made previously (Huet et al., 2009). The L_1 stretching lineation in the marble and dolomites is defined by elongate white mica and, within the schists, is defined by quartz rods, fibrous or slaty phyllosilicates growing in schistosity planes, or elongation of prismatic minerals (glaucophane, epidote; Figure 3c). A subtle NNW-SSE lineation (L_2) is not consistently developed across all lithologies, and is locally preserved as a mineral lineation defined by the reorientation of the earlier L_1 lineation, occurring oblique to the direction oblique to S_2 foliation (Figure 3b). Similar to the CB, the marble and schist units of the CBU record at least two sets of folding that can be distinguished by the orientation of their axes relative to the stretching lineation. The earliest folds (F_1) are dominantly tight to isoclinal and symmetrical recumbent folds, with generally NE-dipping axial planes subparallel to the schistosity and axes with the N-S lineation (Figure 3d; 10c, d). Progressive fold tightening, limb attenuation, and transposition during this deformation contributed to the development of the pervasive S_2 schistosity. A separate set and slightly younger generation of south-vergent, open asymmetric folds, with axial planes dipping to the north and axes perpendicular to the L_1 refolds the regional schistosity (F_2 ; Figure 3e; 10d). Folding of the S_2 schistosity during this event locally generated an axial planar crenulation cleavage (S_3 ; Figure 10e, f). Fold geometry is strongly influenced by lithology and competency contrasts. Marble-rich

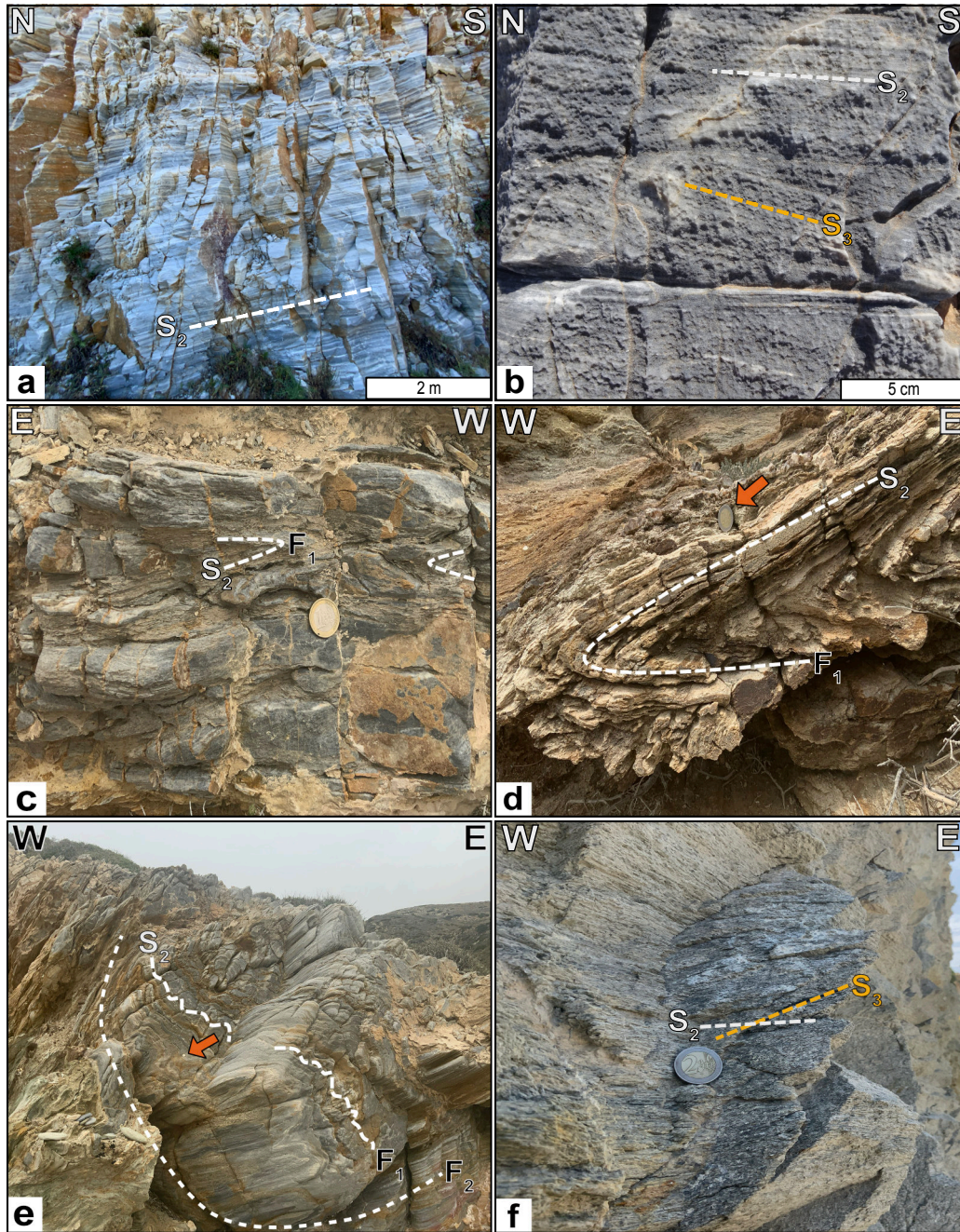


Figure 10. Lithologies and folding relationships within the CBU. (a; E 347439 N 4070377) Photo of a homogeneous, foliated marble with alternating carbonate layers, displaying an S_2 foliation defined by aligned calcite and white mica. (b; E 347439 N 4070377) Planar S_2 foliation within the marble lithology and subsequent axial planar cleavage S_3 which crosscuts the previous foliation. (c; E 345750 N 4068281) Recumbent tightly folded CBU marble schist (F_1). (d; E 345168 N 4065760) Recumbent isoclinal folding (F_1) of S_2 in a wm schist. (e; E 344876 N 4069359) Open folding (F_2) and subsequent refolding with tighter folds (f; E 345801 N 4067771) Axial planar cleavage (S_3) crosscutting and at an angle to the S_2 foliation along the CBU-CB contact.

units typically develop broad, open folds with relatively long wavelengths, whereas micaceous schists are characterized by tighter, more penetrative folding. In some locations, quartz-rich layers exhibit boudinage, indicating possible stretching of the fold limbs. At the island scale, the distribution of the marble and schist lithologies defines long-wavelength, high-amplitude folds with N-S trending fold axes (Figure 2). The S_3 crenulation cleavage forms an island-wide fabric that defines two principal orientation sets, which are commonly spatially restricted, but can occur within the same outcrop (Figure 3d, e). The first population comprises east-west striking, north-dipping axial planes (Figure 3d). The second comprises NNW-SSE striking, north-east dipping planes axial planes. The development of crenulation cleavage is spatially variable, with some outcrops exhibiting well developed axial planar crenulation cleavage (S_3), where others preserve only weak crenulation or localized smaller scale folding, which has also been documented by previous authors (Huet et al., 2009, Thomson et al., 2009). Kinematic indicators occur within the marble unit, and comparable to the CB, the subsequent folding makes it difficult to identify the top-to-north or top-to-south kinematic indicators which denote shearing directions. Brittle-ductile structures were identified such as flanking and bookshelf structures (Figure 11a), and ductile structures like anastomosing quartz bands, sigmoid's, and localized cm-scale shear bands (Figure 10b, c).

White mica of the undifferentiated schists within the CBU makes up to 60% of the rock volume, and two orientations are noted, with the main set defining foliation (S_2), and a second population randomly oriented and oblique to the foliation (Figure 11b, e). The second generation is not as common in the CBU as within the CB. Late white mica and calcite overgrow earlier feldspar porphyroclasts, which appear to preserve an earlier ductile fabric (S_1 ; Figure 11b, d, e). In one sample, white mica is heavily deformed and folded, exhibiting alteration rims and lacking

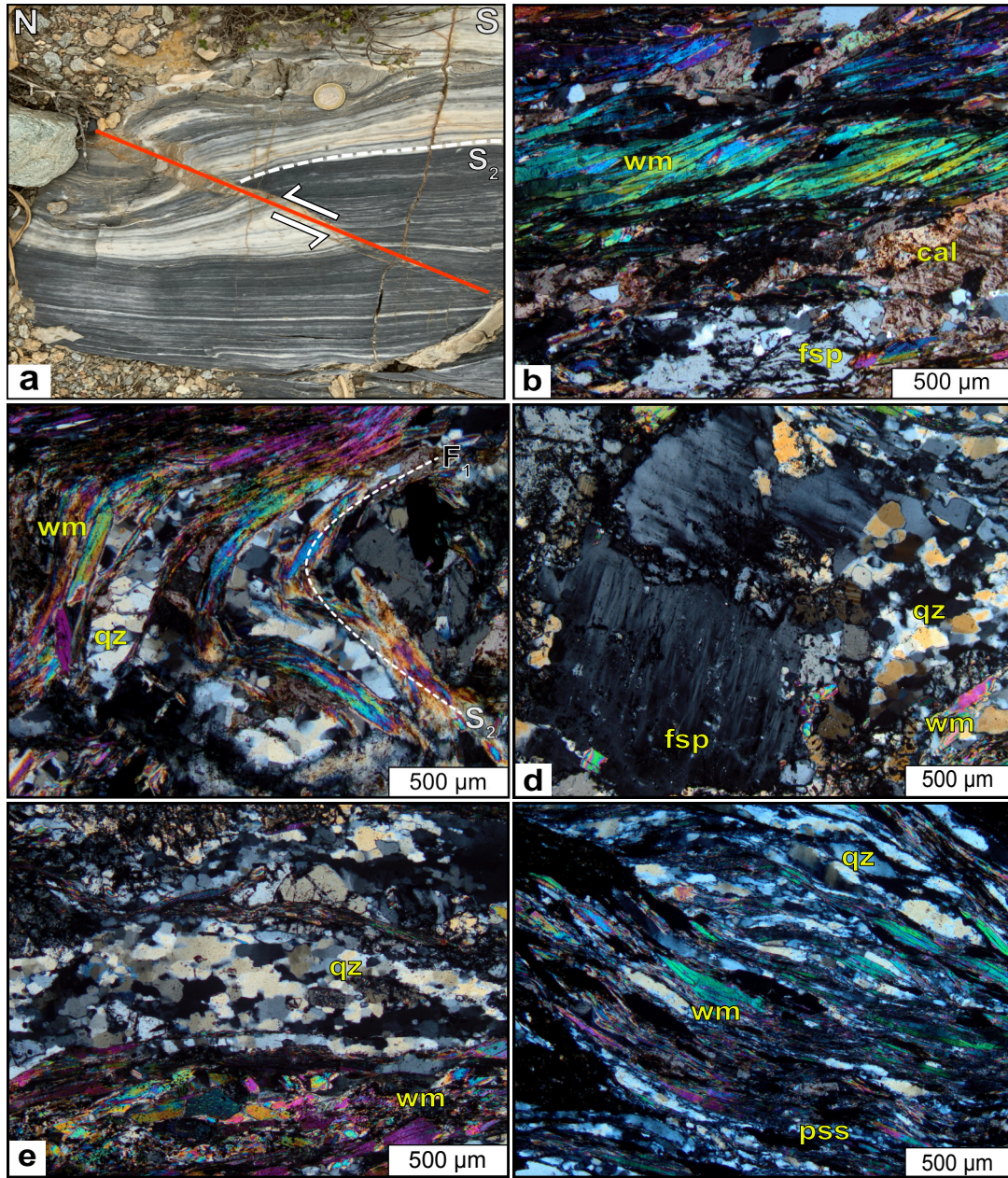


Figure 11. Field photos and photomicrographs of marble and mica-schist units within the CBU. (a; E 345027 N 4069088) Top-to-north flanking structure in marble unit cutting across foliation planes and offsetting marble layering. Red line shows the offset plane. (b; E 347298 N 4070175) Calcite mica schist from the CBU. Late white mica and calcite overprint earlier feldspar and quartz. White mica aligned in 0.5-1 cm thick bundles (CS24-10) (c; E 347298 N 4070175) Carbonate white mica schist from the CBU. Folding of the white mica defines an axial planar crenulation parallel to S_2 (S_3 ; CS24-10). (d; E 347152 N 4069612) wm schist with feldspar porphyroblasts showing fracture sets which are filled with inclusions and recrystallized grains. (CS24-20) (e; E 346351 N 4067478) Quartz vein with equant grains and lobate grain boundaries (CS24-11). (f; E 347152 N 4069612) Quartz mica schist from the CBU displaying weakly folded, undulous white mica grains, and dark pressure solution seams (CS24-20). See Table S1 for sample locations.

cleavage, with pressure solution seams and alteration at grain boundaries (Figure 11c). Most feldspar grains possess fracture sets which are filled with inclusions and recrystallized grains (Figure 11f). Recrystallized quartz makes up 30-40% of the rock and occurs in the strain shadows of feldspar porphyroclasts, as well as within 0.5-5 cm-thick quartz veins. Quartz is deformed through bulging and subgrain rotation, with extreme grain size reduction, and commonly straight grain boundaries with some lobate boundaries (Figure 11e). One sample contains localized shear bands, which are intensely mylonitized with irregular quartz grain boundaries (Figure 11f). Pressure solution seams commonly concentrated within the "hinges" of microfolds. The folded S_2 fabric defined by aligned white mica resulted in a weakly crenulated fabric in some samples (S_3 ; Figure 11f). Evidence of retrogression is locally preserved particularly in the metabasite and schistose lithologies, where high-pressure mineral assemblages (e.g., glaucophane, omphacite, garnet) appear partially replaced by chlorite, albite, and epidote.

On the western coast near Ios harbor, transects across the contact of the CBU-CB reveal that the contact between the two units is folded (Figure 12). Although discontinuous traces of mylonitization within the orthogneiss occur near the contact, there is no obvious pervasive strain gradient toward the contact in the middle of the island (Figure 12a). Pinch-and-swell structures and asymmetric quartz boudins occur across the contact in both units (Figure 8d; 12a). At the contact in the east, localized shear bands record top-to-north kinematics and are associated with asymmetric folding, as well as high-angle normal faulting accompanied by cataclasite development (Figure 12c, d). These cataclastic zones overprint and locally exploit earlier ductile top-to-north structures (Figure 12c). The presence of brittle, high-angle normal faults indicates that the contact is not a simple planar boundary, but instead forms part of a broader, north-dipping fault zone, commonly referred to as the André Fault (Figure 2). Subsequent brittle

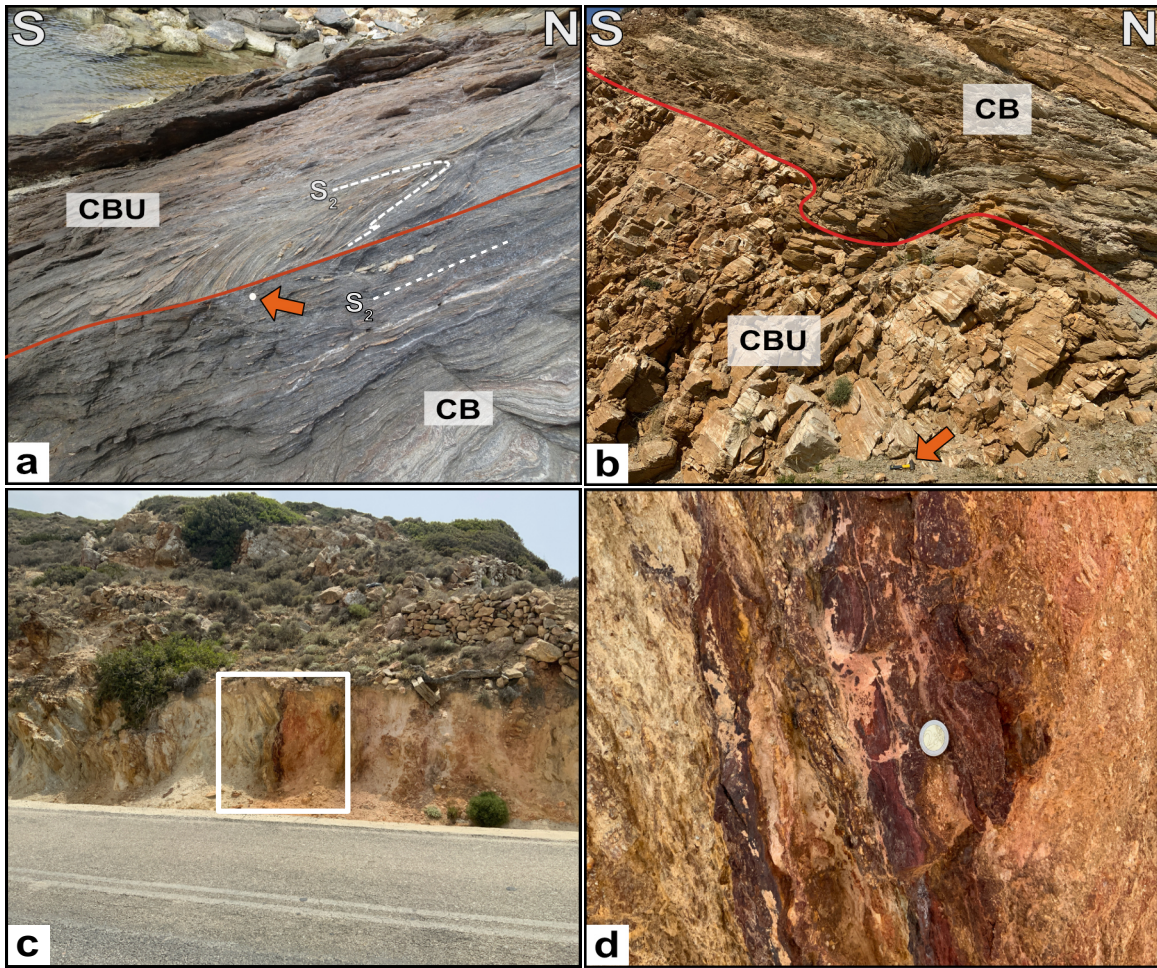


Figure 12. Field photos of contact between Cycladic Basement (CB) and Cycladic Blueschist unit (CBU). (a; E 345067 N 4065750). Sharp contact (trace shown in red) between schists of the CB and CBU along the eastern coast of Ios. No apparent strain gradient is observed approaching the contact. The S_2 foliation within the CBU is folded adjacent to the contact, whereas the S_2 within the CB is parallel to the contact. (b; E 352118 N 4067086) Large outcrop exposure of the CB-CBU contact highlighting openly folded marble and schist units. (c, d; E 345836 N 4067746) Zoomed out view of a late high angle normal fault crosscutting the contact. Inset box highlights the cataclasite gouge within this later brittle fault.

deformation along this contact has further overprinted earlier structures, making its continuity and precise trace difficult to identify across the island.

White Mica Chemistry and $^{87}\text{Rb}/^{86}\text{Sr}$ Geochronology

Cycladic Basement

Four samples were selected for $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology from the Cycladic Basement. Samples CS24-12 and CS24-21 were collected from the orthogneiss lithology, are less deformed, with well-preserved feldspar augens, and with white mica (100-800 μm scale; 2:1 aspect ratio) concentrated in discontinuous or anastomosing bands that wrap feldspar and garnet porphyroclasts (Figure 4d). Both samples also preserve a secondary generation of randomly oriented grains (200-500 μm scale; 2:1 aspect ratio) overprinting the main foliation (Figure 4b). Sample CS24-16, a garnet-mica schist from southern Ios, is notably mica-rich (up to 90% of the rock), with mica up to 800 μm long and an aspect ratio of 2:1 that define a primary foliation. Coarser mica grains are oriented obliquely to the main foliation and display moderate chlorite alteration. Lastly, sample CS24-05 was collected from the Headland Shear Zone, and is from a strongly mylonitized mica schist containing aligned white mica (up to 4 mm long; 3:1 aspect ratio) defining an S-C fabric alongside a potentially later population of more equant, randomly oriented grains (Figure 4b). Geochemical analyses of these four samples across the CB show clustering of micas between 3.2-3.4 Si a.p.f.u. and plot toward muscovite-caledonite compositions (Figure 13). The exception is CS24-16, which plots toward paragonite (3.0 Si a.p.f.u.), although one spot from this sample overlaps with the muscovite field (Figure 13). Geochronological results from the HSZ (CS24-05) sample yielded a date of 24.4 ± 2.7 Ma (MSWD: 0.9; n: 115; Figure 14a), whereas two of the orthogneiss samples yielded similar ages

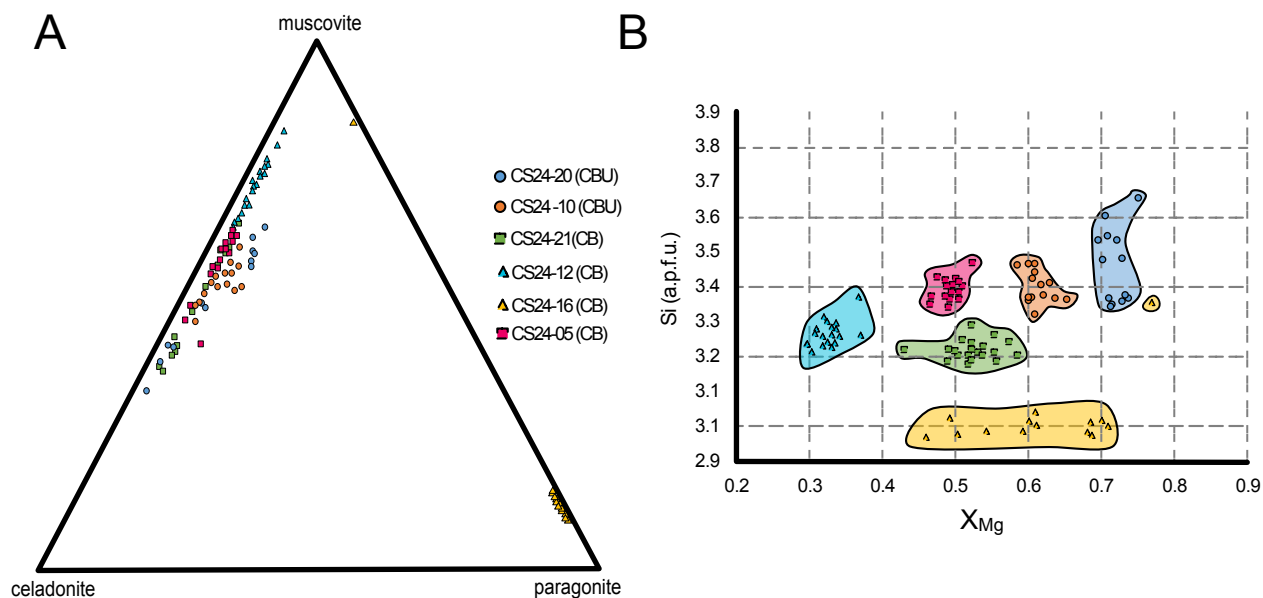


Figure 13. Compositional diagrams for white mica in samples selected for in situ $^{87}\text{Rb}/^{87}\text{Sr}$ geochronology from the Cycladic Basement (CB) and Cycladic Blueschist Unit (CUB). (a) White mica ternary compositional diagram showing variations between muscovite, celadonite, and paragonite end-members. (b) White mica Si apfu vs X_{Mg} plot, with coloured fields encompassing the compositional range of individual spots. Colours and symbols correspond to individual samples as identified in the legend See Table S2 for details.

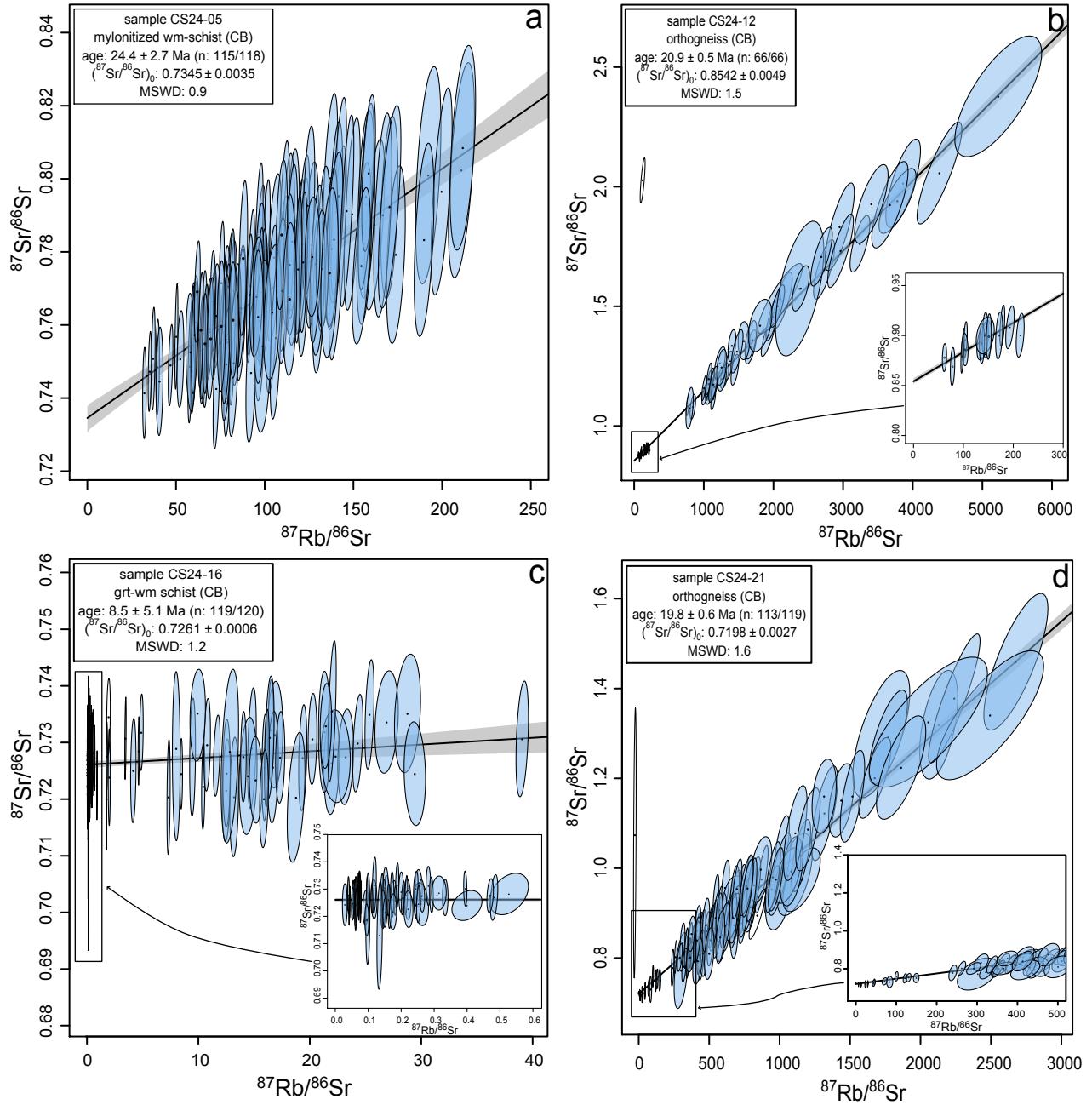


Figure 14. In situ white mica $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology from the CB unit on Ios. (a) Mylonitized, recrystallized white mica for a wm schist sample from the Headland shear zone (CS24-05). (b) white mica for an orthogneiss sample from the south-central part of the CB unit (CS24-12). (c) white mica for a Grt-wm schist from the CB-CBU contact on southern Ios (CS24-16). (d) white mica in an orthogneiss (CS24-21). Inset shows analysis at the origin. Blue coloured ellipses used in age regression; colourless ellipses are data not used. See Table S3.1 and S3.2 for details.

of 20.9 ± 0.5 Ma (CS24-12; MSWD: 1.5; n: 57; Figure 14b) and 19.8 ± 0.6 Ma (CS24-21; MSWD: 1.6; n: 105; Figure 14d). Sample CS24-16, with the elevated paragonite chemistry, has a younger age with high uncertainty of 8.5 ± 5.1 Ma (MSWD: 1.2; n: 109; Figure 14c).

Cycladic Blueschist Unit

Two samples were collected from the CBU for geochronological and geochemical analyses. Both samples are from undifferentiated mica schists which preserve well-developed schistose foliation and contain evidence for multiple deformation events. CS-24-10 is a calcitic white mica schist from the southern CBU, close to the CB-CBU contact. White mica is up to 3 mm in length (2:1 aspect ratio), and forms 1 mm thick N-S oriented bands defining the main foliation (Figure 11c). These grains occur in bundles separated by quartz-rich domains, with recrystallized micas oblique to the primary fabric. Mica in this sample is folded, and individual grains display variable internal deformation, including undulous extinction and local bending. Sample CS24-20 was taken from a garnet-mica schist within the CBU. This sample exhibits similar 2:1 aspect ratio with grains up to 2 mm in length defining an earlier S_1 foliation that has been subsequently folded and crenulated (S_3 ; Figure 11d). Mottled white mica are then overprinted by calcite. Despite slight microstructural differences, both samples show broadly consistent mica chemistry, clustering between 3.4-3.5 Si a.p.f.u. and plotting at muscovite with minor dispersion (Figure 13). The samples yield Oligocene Rb-Sr dates of 30.7 ± 1.4 Ma (CS24-10; MSWD: 1.8; n: 100; Figure 15a) and 27.5 ± 5.7 Ma (CS24-20; MSWD: 1.5; n: 60; Figure 15). Geochronology results from spot analyses indicate that white mica grains oblique to the main foliation yield Rb-Sr ages that fall within the same range as mica defining the foliation.

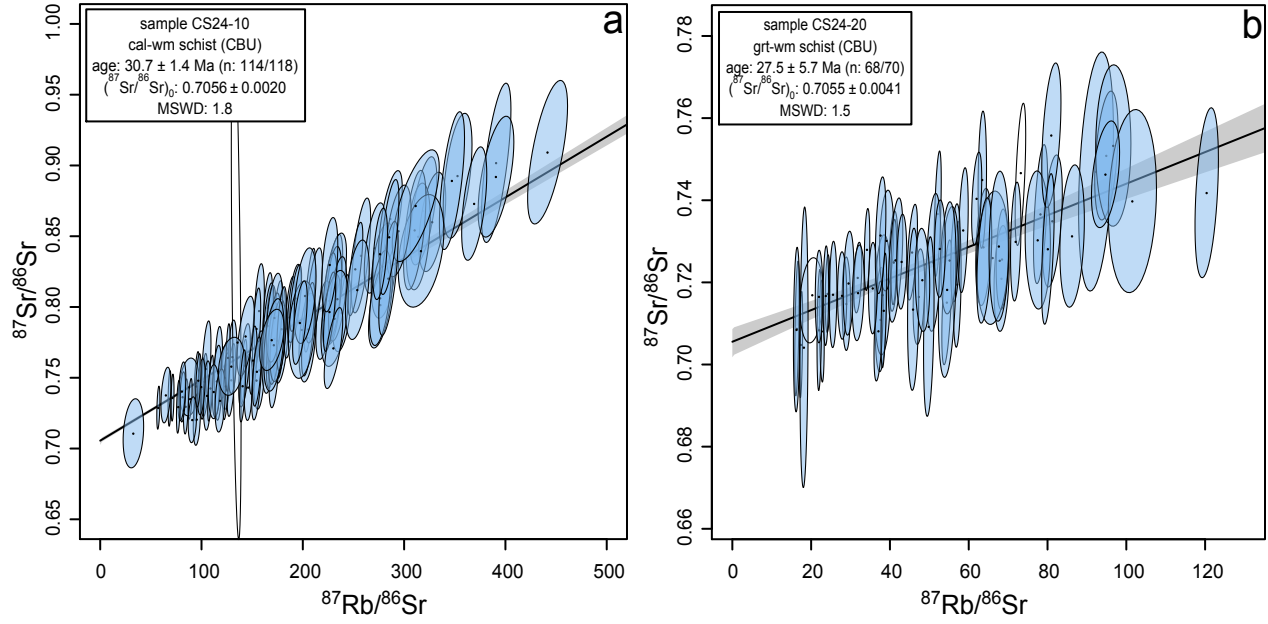


Figure 15. In situ white mica $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology from CBU on Ios. (a) white mica for a cal-wm schist sample (CS24-10). (b) White mica for a grt-wm sample (CS24-20). Blue coloured ellipses used in age regression; colourless ellipses are data not used. See Table S3.1 and S3.2 for details.

No systematic age or geochemical differences are resolved between these populations, and the limited scatter of the dataset does not support the presence of two distinct age populations.

Discussion

The primary objective of this study was to investigate the structural relationships between and within the Cycladic Basement and Cycladic Blueschist unit on Ios, with a particular focus on reconciling opposing shear sense indicators. The relative timing of deformation, including folding, and significance of the island's shear zones remain debated as Ios has long been regarded as a classic Cycladic metamorphic core complex (Lister et al., 1984). Opposing kinematic indicators identified across the island present a fundamental challenge to existing tectonic models because they are inconsistent with the expectation that a high strain ductile shear zone records a single, dominant transport direction. In high strain ductile shear zones, progressive non-coaxial deformation commonly results in the transposition and overprinting of earlier fabrics, progressively obscuring clear evidence of previous kinematics (Bell, 1981). Consequently, if multiple episodes of ductile shearing affected Ios, the youngest deformation should have largely overprinted earlier kinematic indicators, particularly within zones of high finite strain. The widespread preservation of both top-to-north and top-to-south shear sense indicators on Ios requires further explanations where either incomplete transposition of earlier fabrics, strain partitioning, competing shear directional events, or an alternative mechanism capable of preserving contrasting kinematic signatures occurred (Fossen and Cavalcante, 2017).

Opposite shear sense indicators have been documented in ductile shear zones and may form through several mechanisms. They may record multiple deformation events with true kinematic reversal, reactivation of the same foliation or shear plane during subsequent

deformation, or spatial variations in flow during a single deformation event (Fossen and Cavalcante, 2017; Dutta and Mukherjee, 2019). Alternatively, apparent kinematic opposition may result from geometric effects, including observation on non-ideal section surfaces, apparent asymmetries produced by general shear, folding, or pre-existing kinematic indicators (Passchier and Williams, 1996; Grasemann et al., 2018). Distinguishing between these possibilities is essential because the opposite shear senses do not necessarily imply separate deformation events. Instead, their significance depends on their structural context, including their relationship to planar foliation, fold geometry, stretching lineations, and other cross-cutting elements. Consequently, the preservation of opposing kinematics on Ios presents a fundamental challenge for reconstructing the islands' tectonic evolution and assessing the origin of the shear zones that underpin metamorphic core complex models.

The following discussion evaluates the structural relationship between kinematic indicators, shear zone development and folding to assess the mechanisms responsible for the preservation of opposing shear sense on Ios and determine which interpretation is most robust regarding the field and microstructural observations presented in this study.

Field observations

The new field observations from Ios are broadly consistent with those reported in previous studies; however, they provide new insights that challenge existing interpretations of the island's structural architecture and tectonic evolution, particularly in the context of its development as a metamorphic core complex. Across the Cycladic Basement (CB), which forms the domal core of the island, and the Cycladic Blueschist Unit (CBU), a penetrative schistose foliation is the dominant fabric observed within the garnet-mica schists and marble schists, and a

gneissic foliation within the orthogneiss (S_2), consistent with previous structural studies (Forster and Lister, 1999; Huet et al., 2009). This pervasive foliation is predominantly N-S striking, moderately to steeply dipping and is associated with a N-S trending stretching lineation (L_1), consistent with previous observations (Lister et al., 1984; Vandenberg and Lister, 1996; Huet et al., 2009). The continuity of S_2 and L_1 across lithological contacts demonstrates that deformation was pervasive throughout the crustal section rather than partitioned into discrete lithotectonic domains.

Within both the CB and CBU, at least two sets of folding can be identified. The earliest folds are isoclinal, symmetrical, and commonly recumbent, with NE-dipping axial planes and are particularly well developed within the marble-schist sequences of the CBU. These folds are interpreted to have contributed to the development of pervasive schistose/gneissic foliation (S_2) and associated structures (Figure 4g; Forster and Lister, 1999; Huet et al., 2009). Comparable fold geometries are also observed within the CB, where they are accompanied locally by less common, south-vergent, open, asymmetrical folds (Figure 5f). A late generation of open, upright inclined folds are also present, characterized by broader geometries and less penetrative deformation (Figure 10e). These later folds deform the earlier S_2 foliation across all lithologies and scales, folding the mica-garnet schists together with the CBU marble sequences and CB orthogneiss (Figure 2; 12b). Associated with this later folding is the development of axial planar crenulation cleavage (S_3), which consistently overprints the earlier foliation and locally modifies pre-existing kinematic indicators within both the CB and CBU. The S_3 cleavage is developed in the garnet-mica schists, orthogneiss, and marble schist sequences and is locally subparallel to S_2 , but more commonly intersects it at an oblique angle. Stereonet analysis of S_3 measurements reveals two dominant orientation populations across the island: a NNW-SSE striking,

NE-dipping population and a east-west striking, north-dipping population (Figure 3c). In some localities, more than one generation of crenulation cleavage is preserved, suggesting repeated folding and progressive deformation during syn- to post-orogenic exhumation. Collectively, these fabrics and folding relationships define the domal architecture of Ios at the island-scale. The island is characterized by concentric foliation patterns and a pervasive north-south trending stretching lineation and were interpreted by Huet et al. (2009) to have developed during syn-subduction to syn-orogenic exhumation. The continuity of these structures across the CB-CBU contact indicates that dome formation was expressed throughout the crustal section rather than being confined to a single structural level. The two dominant orientations of S_3 are interpreted to reflect progressive rotation of fold axial planes during development of the dome.

The relationship between folding and earlier shear fabrics has significant implications for kinematic interpretations. Opposing kinematic indicators are observed within both the CB and CBU, often within the same outcrop, and have been the subject of considerable debate (Forster and Lister, 1999; Huet et al., 2009; Thomson et al., 2009; Augier et al., 2015; Flansburg et al., 2019; Tsourtis et al., 2025; Flansburg et al., 2026). Previous studies have proposed contrasting relationships between folding and ductile shearing on the island. Forster and Lister (1999) interpreted isoclinal folding as pre-dating crustal-scale top-to-south shearing, whereas later open folding occurs after the principal phase of deformation. In contrast, Huet et al. (2009) viewed folding, dome development, and finite strain as components of a progressive tectonic evolution involving early thrust-related deformation followed by extensional overprinting, rather than discrete pre- and post-shearing events. Geochronological and structural data presented by Thomson et al. (2009) further relate folding to dome exhumation and the evolution of the Headland Shear Zone, whereas Forster and Lister (2009) proposed that the opposing shear

systems developed during temporally distinct episodes of deformation. Together, these models illustrate the lack of consensus regarding the timing and tectonic significance of folding relative to shearing on Ios and provide the context within which the structural relationships documented in this study are evaluated. The observations presented herein indicate that folding broadly post-dates the development of shear-related structures, since axial planar crenulation cleavage (S_3) overprints the shear fabric. This relationship is particularly evident when considered in the context of fold geometry, where the apparent sense of shear may vary depending on the structural position within a fold. In upright limbs, foliation (S_2) appears steeper than axial planar cleavage (S_3), whereas in overturned limbs this relationship is reversed (Figure 6). Therefore, shear sense indicators that originally formed along a particular horizon will appear kinematically opposed after folding of that layer. As a result, shear sense indicators may be misleading without accounting for fold geometry and limb orientation, suggesting the apparent bidirectional shearing on Ios is an artefact of folding. Recent geochronology on mylonite's in the CB and CBU indicate that shearing is Paleozoic (see discussion of geochronology below; Flansburg et al., 2026). The observations presented here suggest that many of the opposing shear sense indicators on Ios do not require separate episodes of top-to-north and top-to-south ductile shearing. Instead, their distribution is more readily explained by the structural reorientation of pre-existing kinematic indicators during progressive folding. Opposite shear sense criteria on Ios commonly occur on opposing fold limbs, remain parallel to the same folded foliation, and lack consistent cross-cutting relationships indicative of discrete shear events. These relationships imply that the present-day asymmetry of many kinematic indicators reflects folding of sheared horizons rather than true kinematic reversal. Consequently, assigning transport direction based on isolated shear

sense indicators without considering fold geometry and structural context may lead to erroneous interpretations of the tectonic evolution of Ios.

One potential explanation for the longstanding debate surrounding kinematic interpretations on Ios is the difficulty in distinguishing between S-C (or S-C-C') structures and axial planar crenulation cleavage in the field. Although these structures may appear similar in outcrop, they form through very different processes. The S-C structures develop during simple shear, where a pre-existing (S) foliation is progressively rotated and drawn into the fabric to form shear bands (C-surfaces) which form parallel to the shear plane, producing a consistent angular relationship between S and C surfaces (Bell, 1981; Lister and Snoke, 1984). In contrast, axial planar cleavage forms during folding, with the newly formed cleavage plane approximately parallel to the axial surface, commonly crosscutting earlier fabrics because of the tight micro-folding of a pre-existing foliation, thereby creating a secondary fabric (Bell, 1981; Bell and Rubenach, 1983). On Ios, field observations indicate that axial planar cleavage commonly exhibits geometries that closely resemble S-C fabrics (Figure 16). This possible confusion likely contributed to misinterpretation of cleavage as shear fabrics in previous studies, leading to conflicting kinematic interpretations. Previous authors have suggested that late stage folding during exhumation may occur under lower strain conditions after detachment activity has ceased and may appear compressional despite being post-orogenic (Jolivet and Brun, 2010; Ring and Glodny, 2021). Collectively, the recognition that axial planar cleavage may appear similar to shear fabric and that late-stage folding may post-date detachment activity challenges models invoking continuous crustal-scale shearing and long-lived syn-tectonic folding within the so-called South Cyclades Shear Zone.

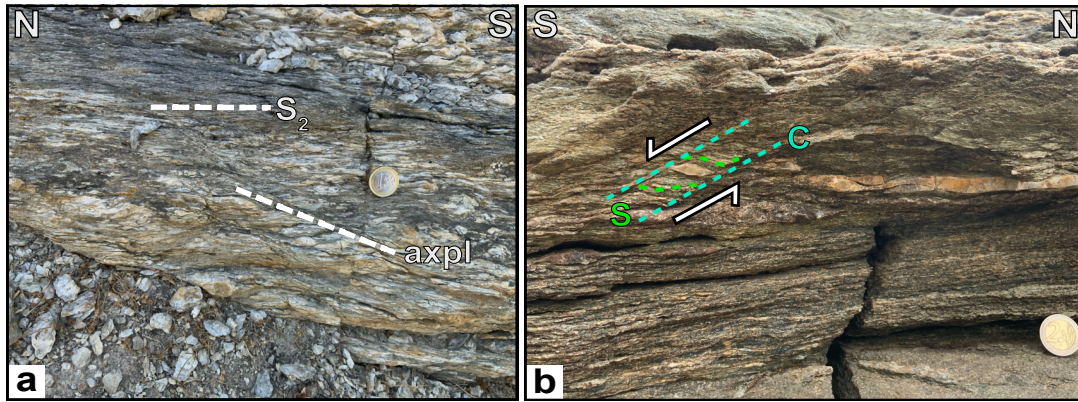


Figure 16. Field photos of axial planar crenulation cleavage and S-C fabrics in the field. (a; E 353509 N 4061647) axial planar crenulation cleavage crosscutting a the pre-existing S_2 foliation within a cal-wm schist within the CBU, (b; E 353965 N 4061545) top-to-south S-C fabrics within a shear band of a grt-wm schist in the CB. axpl: axial planar crenulation cleavage.

The relative timing of folding helps refine the deformational history of Ios. As folding is a ductile process, it develops where deformation is accommodated by distributed viscous or crystal-plastic mechanisms rather than brittle failure. Such conditions are commonly associated with moderate temperatures and pressures characteristic of the middle crust, where deformation is dominated by crystal-plastic flow. However, ductile folding may also occur at shallower crustal levels where sufficiently low strain rates allow deformation to be accommodated by time-dependent mechanisms such as pressure solution and dissolution-precipitation creep, as observed in many fold-and-thrust belts (Bell, 1981; Fossen and Cavalcante, 2017). Microstructural observations from both units indicate that quartz deformation was accommodated by bulging recrystallization to subgrain rotation recrystallization, corresponding to temperatures of ~350-400°C (Stipp et al., 2002).

These temperatures are lower than those associated with peak metamorphism on Ios (475-550°C) indicating that ductile deformation continued after peak metamorphic conditions, during a later stage of the P-T evolution when rocks had cooled to lower temperatures. At temperatures of ~350-450°C, deformation may still be accommodated by crystal-plastic mechanisms, including dislocation creep, dynamic recrystallization, and dissolution-precipitation creep, permitting continued folding and cleavage development prior to the transition to predominantly brittle deformation (Stipp et al., 2002). Consequently, the late open folding and associated S_3 crenulation cleavage are interpreted to have developed during one of the final ductile deformation phases on Ios. Previous studies and the structural observations presented here interpret S_2 as the principal penetrative foliation formed during the earlier syn-subduction to early-exhumation history of the island (Forster and Lister, 1999; Huet et al., 2009). The rocks' mineral assemblage was variably re-equilibrated during subsequent greenschist facies

retrogression, as evinced by the widespread replacement of peak metamorphic assemblages (garnet, rutile, white mica, glaucophane, clinozoisite) by chlorite, albite epidote and recrystallized white mica documented throughout both the Cycladic Basement and Cycladic Blueschist Unit (Flansburg et al., 2019; Wolfe et al., 2023; Peillod et al., 2024). The overprinting relationship of S_3 on S_2 demonstrates that crenulation cleavage development post-dated the principal regional foliation and represents one of the youngest ductile deformation events preserved on the island.

Establishing the timing of folding also provides an important framework for evaluating the larger scale structural architecture of Ios. In particular, the relative timing and distribution of deformation have direct implications for the tectonic significance of the contact between the CB and CBU, which has long been interpreted as the principal crustal-scale structure (SCSZ, Ios Detachment) defining the Ios metamorphic core complex. The structural significance of the contact between the CB and CBU has long been central to tectonic models for the island. However, the observations presented in this study, together with recent structural and metamorphic constraints, suggest that the boundary is more consistent with a folded lithological contact that experienced a shared tectonometamorphic history. Historically, this boundary has been interpreted as a major tectonic interface, either as a south directed-crustal scale shear zone or a thrust (Lister et al., 1984; Huet et al., 2009). However, structural observations from this study indicate that the contact is folded, laterally discontinuous, and lacks a distinct strain gradient on either side. Strain within the orthogneiss varies spatially and does not systematically increase toward the contact, consistent with observations of Huet et al. (2009). In several locations, the contact is difficult to identify, either because it is transposed into surrounding fabrics or overprinted by younger, brittle high-angle normal faults. Metamorphic constraints

similarly fail to support the existence of a major tectonic break. Both units record comparable peak metamorphic conditions of ~500-550°C and 16-20 kbar (Augier et al., 2015; Wolfe et al., 2023), consistent with a shared Eocene high-pressure metamorphic history. This interpretation is further supported by zircon U-Pb geochronology, which documents Early Eocene (c. 50 Ma) metamorphic zircon rim growth in both the CB and CBU, indicating that the two units experienced the same metamorphic event and were either in contact prior to subduction or juxtaposed within the subduction channel before regional exhumation (Flansburg et al., 2019; Poulaki et al., 2019). The absence of a marked metamorphic discontinuity implies that the two units occupied similar crustal levels during peak metamorphic conditions and were likely brought together in the subduction channel (Wolfe et al., 2023) and exhumed as a coherent nappe.

Although most of the shearing on Ios can be shown to have occurred pre-folding, one shear zone appears to have formed post-folding. The Headland Shear Zone is identified as a top-to-north ductile shear zone that consistently overprints both the regional S_2 foliation and the younger S_3 crenulation cleavage. The HSZ is located at the southern mica schist contact with the orthogneiss of the CB and is defined by mylonitic foliation in a continuous east-west striking structure that can be traced across the island, extending its previously mapped extent (Vandenberg and Lister, 1996). Unlike the previously proposed SCSZ, which lacks structural continuity and a consistent strain gradient, the HSZ exhibits the characteristics expected of a discrete shear zone, including continuous fabric development, localized strain, and consistent top-to-north kinematic indicators (S-C bands, σ -type feldspar porphyroclasts; Figure 9a). The systematic overprinting of both S_2 and S_3 fabrics demonstrates that the HSZ post-dates regional folding and therefore presents the youngest recognized phase of ductile deformation on Ios. This

relationship provides an important temporal marker within the island's deformational history, indicating that development of the regional penetrative fabric and associated folding pre-dated localized shearing within the HSZ. Consequently, the HSZ is best interpreted as a late-stage deformation zone that overprints, rather than generates, the island-wide structural framework.

The structural relationships documented here further suggest that the tectonic significance of the HSZ differs from that previously attributed to the SCSZ. Rather than representing a crustal-scale extensional detachment responsible for juxtaposing the CB and CBU or accommodating the majority of exhumation, the HSZ appears to have localized deformation during the final stages of ductile evolution. Its restricted distribution within the CB, together with the absence of a progressive strain gradient or metamorphic discontinuity across the CB-CBU contact, indicates that it likely did not accommodate the regional domal architecture or the tectonic assembly of the two units. Instead, the pervasive S_2 foliation, regional folding, and domal geometry are interpreted to record an earlier, island-wide deformational history that was subsequently overprinted by localized shearing within the HSZ.

Following development of the HSZ, deformation became increasingly brittle, localizing along such structures as the André Fault System, which crosscuts both the CB and CBU and produces cataclasis along discrete planes. These brittle faults represent the final stages of exhumation and crustal extension. Although comparable late-stage extensional structures elsewhere in the Cyclades are commonly associated with major metamorphic discontinuities, no such discontinuity is observed across the CB-CBU contact. Instead, the progressive localization of deformation from regional ductile fabrics to the HSZ and ultimately to brittle faulting records the final stages of the islands tectonic evolution without requiring the presence of a crustal-scale extensional shear zone at the CB-CBU contact.

Collectively, the structural observations presented here challenge the interpretation of Ios as a crustal section dissected by a long-lived South Cyclades Shear Zone as proposed by Forster and Lister (1999). Overprinting relationships demonstrates that progressive deformation during syn- to post-orogenic exhumation including development of the regional S_2 fabric, subsequent folding and S_3 crenulation cleavage formation, late-stage ductile shearing within the Headland Shear Zone, and final brittle faulting during exhumation. Furthermore, the CB-CBU contact lacks structural, metamorphic, and geochronological characteristics expected of a major tectonic boundary, suggesting that it instead represents a folded lithological contact. These interpretations provide the structural framework within which new and existing geochronological data can be evaluated.

Geochronology

White mica as a geochronometer is sensitive to isotopic resetting caused by deformation, heating, and fluids (e.g., Cossette et al., 2015; Barnes et al., 2023). The application of in-situ laser ablation $^{87}\text{Rb}/^{87}\text{Sr}$ geochronology to white mica provides a powerful tool for potentially resolving the timing of these processes. The new Rb-Sr dates reported here largely overlap with previously published datasets, with samples from the CB yielding ages of c. 20 Ma to 24 Ma and samples from the CBU yielding slightly older ages of c. 28 Ma to 31 Ma. The paragonitic phase yielded a younger date of 8.5 ± 5.1 Ma from a mica-schist unit on southern Ios. Because of the paragonitic chemistry, this sample is excluded from further interpretation because its Na-rich composition typically incorporates only minor Rb relative to muscovite and phengite, resulting in low $^{87}\text{Rb}/^{86}\text{Sr}$ ratios and limited radiogenic ingrowth. Consequently, paragonite generally

provides less precise and less reliable Rb-Sr age information than K-rich white mica compositions.

White mica compositions from Ios are visually and chemically homogeneous. High-pressure assemblages are overprinted by chlorite- and muscovite-bearing mineral fabrics, with the development of fine grained white mica aligned with dominant foliation, and white mica compositions indicate a transition from high-Si phengitic compositions to lower Si muscovitic compositions consistent with greenschist facies conditions. Importantly, analyses targeted mica defining the dominant foliation as well as grains aligned oblique to it, yet no systematic differences in age or chemistry are observed between the apparent populations. The mica dates coupled with microstructural observations suggests deformation-related recrystallization associated with a late greenschist facies overprint during exhumation, resulting from retrogression of HP mineral assemblages.

Published Rb-Sr data from Ios are limited; however, regional datasets from the Cyclades provide an important framework for interpreting the new dates presented in this thesis. Rb-Sr ages in white mica primarily record the timing of recrystallization and isotopic re-equilibration, often linked to deformation and fluid activity, as both Rb and Sr are mobile during metamorphism and can be redistributed during mica growth or re-equilibration (e.g., Brocker et al., 1998; Corrie and Kohn, 2011). Across the Cyclades, white mica Rb-Sr ages cluster between 20 and 30 Ma and are interpreted to record widespread greenschist facies overprinting and exhumation-related recrystallization following Eocene high-pressure metamorphism (Bröcker and Franz, 2005; Laurent et al., 2021; Ring et al., 2025). However, the presence of younger Miocene ages, including a 13.2 ± 0.4 Ma phengite date from the Ios basement (Henjes-Kunst and Kreuzer, 1982), indicates that the isotopic system remained susceptible to localized resetting

during late-stage deformation and fluid circulation. The coexistence of Oligocene and Miocene Rb-Sr ages throughout the Cyclades suggests that regional cooling (due to exhumation) alone cannot account for the observed age distribution, and that spatially variable episodes of mica recrystallization and isotopic re-equilibration also contributed to resetting the isotopic system.

A comparison with $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology further supports this interpretation. Unlike Rb-Sr geochronology, which records isotopic equilibration during mineral growth and recrystallization, the $^{40}\text{Ar}/^{39}\text{Ar}$ system primarily records argon retention and diffusion, often interpreted as cooling through a closure temperature (muscovite: 350-450°C) but can also be affected by recrystallization (McDougall and Harrison, 1999; Forster and Lister, 2019). Published $^{40}\text{Ar}/^{39}\text{Ar}$ datasets from Ios reveal an apparent complex tectonothermal history, with ages spanning the Late Cretaceous to the Miocene (e.g., Baldwin and Lister, 1998; Forster et al., 2019). Recent studies have demonstrated that some phengite populations preserve Late Cretaceous and Paleocene dates, indicating that portions of the structural record pre-date Alpine high-pressure metamorphism and were only partially re-equilibrated during later tectonometamorphic events (Forster et al., 2019; Yeung et al., 2021). This incomplete resetting is reflected in $^{40}\text{Ar}/^{39}\text{Ar}$ analyses of augen gneiss, garnet-mica schist, and leucogranite samples, which yielded mixed age spectra extending from pre-Alpine to Oligocene ages (Baldwin and Lister, 1998; Forster et al., 2019). These complex spectra were attributed to incomplete resetting, excess argon retention, inheritance from older metamorphic events, and the presence of multiple argon reservoirs within individual samples.

In contrast, the most robust $^{40}\text{Ar}/^{39}\text{Ar}$ ages are derived from microstructurally constrained white mica from mylonitic augengneiss and associated top-to-north fabrics. Baldwin and Lister (1998) reported white mica dates of 21-25 Ma, which they interpreted as recording

recrystallization during greenschist facies deformation rather than peak high-pressure metamorphism. These ages broadly overlap with the Rb-Sr ages of c. 20-30 Ma from the Cyclades and suggest widespread Oligo-Miocene isotopic re-equilibration during exhumation. The correspondence between these independent isotopic systems indicates that both record the same retrograde greenschist facies deformation event, whereas preservation of older $^{40}\text{Ar}/^{39}\text{Ar}$ ages demonstrates that isotopic resetting was spatially heterogeneous and that portions of the earlier metamorphic history survived later deformation.

Additional timing constraints on the relationship between the CB and CBU are provided by zircon U-Pb data. The Cycladic Basement records Carboniferous magmatism (ca. 300-305 Ma), represented by the Hercynian granite protolith, which is overlain by Permian metasedimentary rocks (ca. 270-295 Ma; Flensburg et al., 2019; Poulaki et al., 2019, 2021). More importantly, zircon U-Pb geochronology provides constraints on the timing of metamorphism and the tectonic relationship between two units. Metamorphic zircon rims from both the CB and CBU yield ages of c. 50 Ma (Poulaki et al., 2019). The occurrence of coeval metamorphic zircon growth in both units suggests that they were already juxtaposed prior to, or during subduction and subsequently shared a common Eocene metamorphic history, supporting a long-lived tectonostratigraphic relationship between the two units that pre-dates Alpine metamorphism. A secondary population of zircon rims yields ages of c. 26 Ma and is restricted to a narrow zone adjacent to the CB-CBU contact (Poulaki et al., 2021). These are spatially limited and absent elsewhere within both units, therefore are more plausibly interpreted as recording localized fluid-assisted metamorphic re-equilibration and zircon recrystallization during exhumation rather than large-scale tectonic juxtaposition. The restricted nature of this overprint contrasts with the island-wide structural and metamorphic continuity observed across

the CB and CBU and therefore provides little support for prolonged displacement along a major crustal-scale shear zone. Collectively, the zircon U-Pb data indicate that the CB and CBU shared both Eocene metamorphism and subsequent exhumation, reinforcing interpretations made in this thesis.

Recent geochronology by Flansburg et al. (2026) reinterprets the origin of the dominant fabrics preserved within the apparent footwall of the so-called SCSZ. Microstructurally characterized apatite U-Pb ages from the high-temperature ($>500^{\circ}\text{C}$) mylonites in the basement core are predominantly Permo-Carboniferous (ca. 307-270 Ma). Although quartz microstructures indicate lower temperature ($300\text{-}400^{\circ}\text{C}$) mylonitization within the SCSZ, U-Pb analyses and complementary electron backscatter diffraction (EBSD) analyses on the apatite from these rocks preserve exclusively Permo-Carboniferous ages, which the authors interpret is the dominant fabric recorded in these rocks, formed during Paleozoic tectonism, rather than products of Oligo-Miocene extensional shearing (Flansburg et al., 2026). This interpretation implies that much of the structural architecture traditionally attributed to metamorphic core complex development was inherited from earlier tectonic events and subsequently reactivated or overprinted during Cenozoic deformation. These findings demonstrate that some structural fabrics within MCC footwalls may significantly pre-date extension-related exhumation and therefore caution against linking mylonitic deformation to Miocene core complex formation without independent geochronological constraints.

Low temperature ($<200^{\circ}\text{C}$) thermochronology provides the most robust constraints on the timing of the latest stages of exhumation on Ios and offers an independent test of whether the CB and CBU experienced differential cooling during Cenozoic extension, as should be expected in the MCC model. Zircon and apatite thermochronometers record cooling through progressively

lower crustal temperatures, with zircon fission track (ZFT) recording cooling through $\sim 240\text{--}280^\circ\text{C}$, zircon (U-Th)/He (ZHe) through $\sim 160\text{--}200^\circ\text{C}$, apatite fission track (AFT) through $\sim 110\text{--}120^\circ$, and apatite (U-Th)/He (AHe) through $\sim 40\text{--}80^\circ\text{C}$, depending on grain size, cooling rate, and radiation damage (Reiners et al., 2005; Reiners and Brandon, 2006; Tagami and Sullivan, 2005). Apatite (U-Th/He) ages from the island cluster tightly between 9 and 11 Ma, with overlapping dates obtained from both hanging wall and footwall rocks (Thomson et al., 2009). Zircon and apatite fission track data similarly record cooling through upper crustal temperatures between 9 and 15 Ma and show no systematic age differences between structural levels (Thomson et al., 2009; Ring et al., 2010). Collectively, these low temperature thermochronological constraints indicate relatively rapid late cooling and exhumation, with comparable cooling histories recorded across both the CB and CBU (Poulaki et al., 2021; Flansburg et al., 2026). If the CB-CBU contact represented a major extensional detachment accommodating large magnitude displacement, differences in cooling ages would be expected between the (older, colder) hanging wall and (younger, warmer) footwall. Instead, the absence of a measurable thermal discontinuity indicates that both units formed part of a single coherent exhuming crustal section during the final stages of exhumation. Analogous Late Miocene fission track ages (5-15 Ma) reported elsewhere in the Cyclades further suggest that a phase of rapid cooling across crustal temperature of $60\text{--}120^\circ\text{C}$ reflects a regional episode of upper-crustal exhumation rather than localized displacement along the CB-CBU contact (Brichau et al., 2006; Hejl et al., 2010). Taken together, the low temperature thermochronological record provides strong evidence against a major tectonic break between the CB and CBU and supports a shared shallow crustal exhumation history across the island. More broadly, geochronological data from Ios define a consistent progression from Eocene HP metamorphism (c. 50 Ma), through

Oligocene-Early Miocene greenschist facies recrystallization and deformation (c. 30-20 Ma), to rapid, spatially uniform cooling of footwall rocks during the Miocene (c. 15-9 Ma).

Headland Shear Zone

The new mica Rb-Sr age obtained from the Headland Shear Zone (24.4 ± 2.7 Ma) provides an important temporal constraint on the final stages of ductile deformation on Ios (Figure 13a). Microstructural observations indicate that the dated white mica formed during mylonitization, as S-C fabrics are well developed and locally overprinted by lower temperature retrograde minerals, such as chlorite, suggesting progressive deformation persisted during progressive cooling and exhumation. Compositional data from the analyzed white mica show slight clustering in Si vs X_{Mg} space, indicating minor chemical heterogeneity within the mineral phase. However, no systematic relationship is observed between Rb-Sr age and silica content, suggesting that isotopic equilibrium occurred broadly across the mica population during deformation, rather than reflecting multiple discrete generations of mica growth. The absence of a systematic relationship between mica composition and age further indicates that the age population records a single deformation-related recrystallization event rather than multiple generations of mica growth. Consequently, the 24.4 ± 2.7 Ma age is interpreted to date the early stages of ductile shearing within the HSZ. This interpretation is supported by previously published geochronological constraints. Forster and Lister (2009) reported $^{40}\text{Ar}/^{39}\text{Ar}$ ages of c. 24-25 Ma from top-to-north shear zones within the Ios basement, which were interpreted as recording deformation related recrystallization during extensional shearing (Forster and Lister, 2009). Additionally, a mica Rb-Sr date of 18 Ma from mylonitic rocks nearby the HSZ (Thomson et al., 2009) indicate that localized recrystallization and isotopic resetting may have

continued into the Miocene. The close agreement between Ar-Ar and Rb-Sr dates strongly suggests that the top-to-north shearing was active during the Oligo-Miocene and represents one of the youngest ductile deformation events preserved on the island. Importantly, although the HSZ can be traced across the island and consistently records top-to-north kinematics, its tectonic significance remains distinct from that traditionally assigned to the South Cyclades Shear Zone. The HSZ clearly overprints both S_2 and S_3 fabrics and therefore post-dates the principal folding event. However, unlike a major crustal-scale detachment, it is not associated with a significant metamorphic or geochronological discontinuity across the CB-CBU contact. The available evidence suggests that the HSZ accommodated localized late-stage strain during exhumation rather than serving as the primary structure responsible for juxtaposing the major tectonostratigraphic units of Ios. Instead, it is interpreted as the final significant episode of ductile deformation preserved on the island, recording continued top-to-north shearing during the later stages of exhumation.

Regional Cyclades

The results of this study provide a basis for reassessing the tectonic evolution of Ios within the broader framework of the Cyclades and challenge its long-standing interpretation as a classical metamorphic core complex. Although Ios is considered one of the first MCCs identified in the Cyclades (Lister et al., 1984), comparison of field observations and geochronological constraints with established MCC criteria reveals that the island does not fully satisfy the defining hallmarks of such systems.

Metamorphic core complexes are generally accepted to define linked structural systems comprising a high-grade ductile footwall, a low-angle extensional detachment zone

accommodating large displacements, and a brittlely deformed, extended hanging wall (Coney, 1980; Lister and Davis, 1989; Whitney et al., 2013; Platt et al., 2015). These systems typically exhibit a clear structural and thermal break across the detachment, with distinct metamorphic histories and cooling paths preserved in the hanging wall and footwall. Although Ios exhibits some features consistent with MCCs, most notably a domal geometry and the presence of ductile flow fabrics, many key elements of this structural framework have been misinterpreted or are absent. This becomes even more prevalent when comparing Ios to other islands within the region.

Collectively, the structural, metamorphic, and geochronological datasets indicate that the CB-CBU contact on Ios does not exhibit the characteristics expected of a major extensional detachment or crustal-scale shear zone. Rather than separating domains with distinct deformation histories, metamorphic conditions, and exhumation paths, the contact juxtaposes units that share remarkably similar tectonometamorphic records. Although the lithological contact can be traced across much of the island, it is folded and locally obscured by transposition into surrounding fabrics or by shallow crustal brittle faulting. Furthermore, it is not associated with the systematic increase in strain, continuous high strain zone, or consistent kinematic translation expected adjacent to a crustal-scale extensional detachment. Instead, high strain fabrics are discontinuously developed along the contact and within adjacent lithologies, suggesting that deformation was localized into discrete zones rather than concentrated along a single, island-scale shear zone. Folding has affected both units, and the development of a pervasive axial planar crenulation cleavage demonstrates that significant folding post-dated the formation of the dominant shearing preserved in the rocks. Consequently, many structures previously interpreted as evidence for opposing shear zones may instead reflect the re-orientation and overprinting of

older fabrics during the latest folding event. Metamorphic and geochronological datasets support this interpretation. Both the CB and CBU record comparable peak-pressure-temperature conditions, coeval metamorphic zircon growth at c. 50 Ma, overlapping Rb-Sr and $^{40}\text{Ar}/^{39}\text{Ar}$ dates associated with recrystallization during exhumation and indistinguishable low-temperature cooling histories. Collectively, these observations indicate that the two units shared a broadly similar tectonometamorphic evolution and do not represent the contrasting histories expected across a major extensional detachment, where the proposed hanging wall should be older and colder relative to the footwall. On Ios, however, the overlapping high-pressure metamorphic conditions recorded by the CB and CBU, together with the apparent continuity of deformation fabric and the absence of a systematic strain gradient toward their contact, provide limited evidence for a major extensional discontinuity. In this framework, the CB-CBU contact is best interpreted as a lithologically controlled boundary that was subsequently folded, locally reworked by discrete shear zones, and later affected by brittle faulting, rather than a regionally significant tectonic discontinuity accommodating large magnitude displacement.

This interpretation is consistent with observations from neighboring Sikinos island (Figure 1), where the equivalent CB-CBU contact has also been the subject of debate. Using zircon U-Pb geochronology from both Ios and Sikinos, Poulaki et al. (2019) demonstrated stratigraphic continuity across the islands and proposed a para-autochthonous relationship between the two the CB and CBU (Poulaki et al., 2019). On Sikinos, the CB and CBU share a common post-Cretaceous tectonometamorphic evolution characterized by Eocene high-pressure metamorphism, subsequent Cenozoic metamorphic overprinting, late extensional faulting, and progressive exhumation (Poulaki et al., 2019). Notably in a similar situation to Ios, structural studies on Sikinos document both north- and south- directed shear indicators within the Cycladic

Basement (Augier et al., 2015; Poulaki et al., 2019). Instead of opposing shear zones, the new Ios model can be extended to Sikinos: The similarity of structural, metamorphic, and geochronological relationships between the two islands suggests that the CB-CBU contact exposed in the southern Cyclades may represent a regionally extensive lithological boundary that was later modified by folding, localized ductile shearing, and brittle extension, rather than a discrete crustal-scale extensional detachment separating tectonic domains with fundamentally different geological histories.

The structural relationships documented on Ios differ markedly from those observed in well-established Cycladic metamorphic core complexes such as Naxos and Ikaria. Previous authors interpreted the Ios and Naxos core complexes as mid-crustal metamorphic rocks drawn upwards and outwards from beneath sedimentary basins now 100 km to the south between 25-11 Ma (Lister et al., 1984; Vanderhaeghe, 2004; Cao et al., 2013;). On Naxos, the dome exhibits the classic architecture of a MCC, consisting of a high-grade core composed of kyanite and sillimanite gneisses and migmatites that are folded into upright structures and structurally overlain by lower grade blueschists and marble schists (Cao et al., 2013; Laurent et al., 2019). These contrasting metamorphic domains are separated by a regionally extensive, top-to-north ductile detachment (Naxos-Paros Detachment System) that was subsequently reactivated as a low-angle normal fault during exhumation (John and Howard, 1995). The detachment juxtaposes rocks that experienced fundamentally different pressure-temperature histories, juxtaposing higher pressure blueschist facies rocks against higher temperature Barrovian metamorphic rocks. Structural mapping demonstrates that the dominant ductile fabrics, folding, stretching lineations, and peak metamorphism preserved within the high-grade core all pre-date development of the

regional extensional detachment, which accommodated the final stages of dome exhumation (Laurent et al., 2019).

A similar structural architecture is observed on Ikaria, where exhumation was accommodated by the Agios Kirykos and Fanari extensional shear zones, which together form a coherent top-to-north extensional detachment system (Beaudoin et al., 2015). Progressive localization of strain from amphibolite to greenschist facies conditions produced a well-developed mylonitic shear zone accompanied by an increase in strain intensity toward the detachment. Ikaria also preserves a pronounced thermal gradient across the shear zone, with temperatures exceeding 600°C in the metamorphic core and decreasing to ~390°C within the hanging wall (Beaudoin et al., 2015; Avigad et al., 1989). These relationships demonstrate progressive localization of both deformation and cooling during extensional exhumation.

Such relationships are notably absent on Ios. Neither a systematic increase in strain toward the CB-CBU contact, nor a significant metamorphic or thermal discontinuity is observed across the proposed detachment. Instead, both units record remarkably similar tectonometamorphic histories and are affected by multiple generations of folding that overprint a pervasive regional foliation developed prior to localized ductile shearing. Consequently, Ios more closely resembles a metamorphic gneiss dome in which doming and folding dominate the structural architecture, rather than a classic metamorphic core complex exhumed along a single crustal-scale extensional detachment. Gneiss domes developed within orogenic belts are commonly attributed to processes such as buoyancy-driven uplift, crustal flow, or progressive fold interference and typically preserve multiple generations of superposed fabrics together with localized, temporally distinct shear zones (Whitney et al., 2004). In these systems, strain is partitioned among discrete zones that evolve through time, producing heterogeneous deformation

patterns and complex overprinting relationships rather than a single continuous crustal-scale shear zone. The structural relationships documented on Ios are more consistent with this style of crustal deformation than with the classic Cycladic metamorphic core complex architecture observed on Naxos and Ikaria. The structural characteristics observed on Ios raise important questions regarding its classification within the framework of typical metamorphic core complexes. Rather than conforming to a typical MCC architecture defined by a single throughgoing detachment and systematic strain localization, the structural relationships on Ios suggest more complexity. Within the regional context of the Cyclades, Ios may be more appropriately interpreted as a metamorphic dome, possessing a lithotectonic contact between the CB and CBU, situated within the hinge zone between oppositely verging extensional systems. Ring et al. (2010) proposed that the Cyclades form part of a large-scale extensional province bounded by major detachments accommodating opposite senses of shear, including the north-directed Naxos and south-directed Santorini detachments (Figure 17a). Situated between these two domains, Ios occupies a structurally transitional position where displacement along individual detachments decreases, strain becomes partitioned across multiple structures, and fabric rotation and mixed kinematic signals are primed to occur (Ring et al., 2010). In such a setting, folding, doming and localized shearing may become more important than displacement along a single crustal-scale detachment. This model provides a relative chronological framework for interpreting the progressive evolution and overprinting of structural fabrics. T_1 represents the initial development of shear-related fabrics within the subduction zone, prior to folding. During T_2 , recumbent folding resulted in the rotation and local inversion of pre-existing fabrics, producing opposing apparent shear senses on different fold limbs. Subsequently, T_3 involved broad folding and doming, further modifying the orientation and spatial distribution of earlier

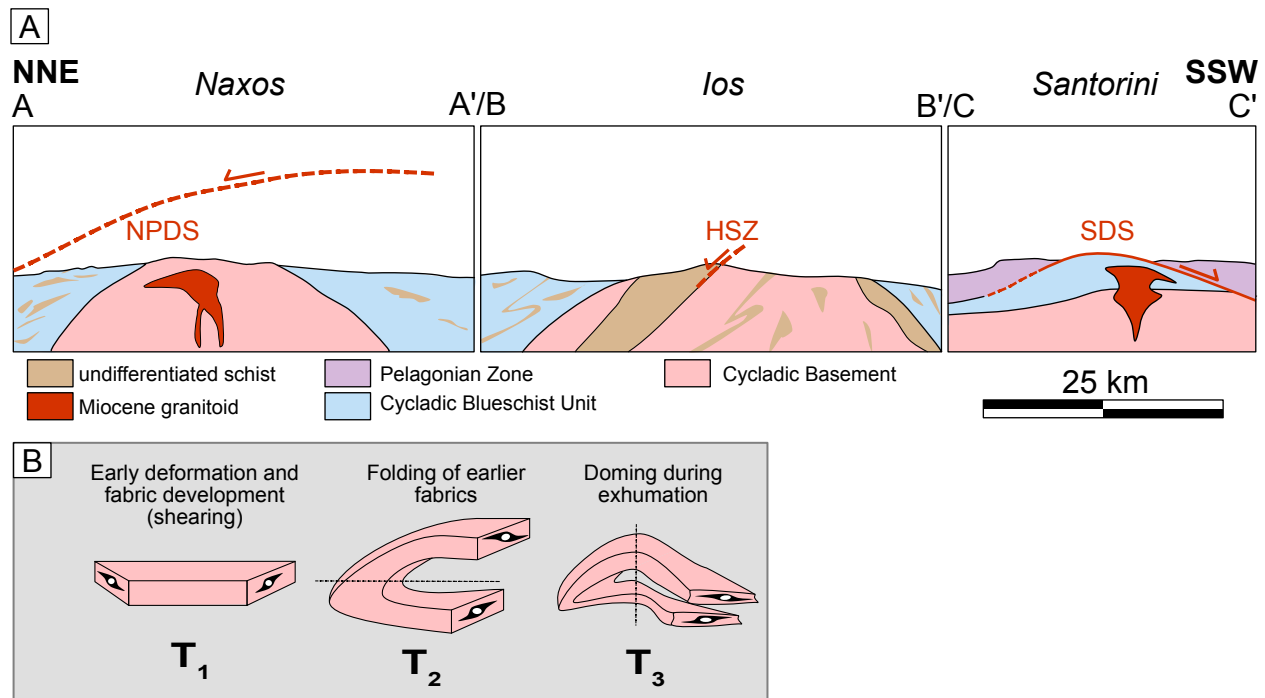


Figure 17. (A) simplified series of cross sections through the Southern Cyclades at c. 15-10 Ma, illustrating the interpreted structural relationships among Naxos, Ios and Santorini. Transects are oriented subparallel to the tectonic transport direction; See figure 1 for location profiles. (B) Conceptual schematic illustrating the progressive modification of pre-existing shear sense indicators through folding and subsequent doming. T_1 represents the initial development of shear-related fabrics prior to folding. During T_2 , recumbent folding with sub-horizontal fold axes rotates and locally inverts these earlier fabrics, producing opposing apparent shear senses on different fold limbs. Subsequent broad refolding with vertical fold axes and doming during T_3 further modifies the orientation and spatial distribution of previous fabrics. NPDS: Naxos-Paros Detachment System; HSZ: Headland Shear Zone; SDS: Santorini Detachment System.

fabrics. Brittle deformation continued beyond T_3 , representing the later stages of structural evolution (Figure 17b). The resulting structure preserves a composite tectonic record in which Paleozoic basement fabrics, Eocene high-pressure metamorphism, Oligocene-Miocene folding, localized shear zone development, and late-stage brittle extension are superposed within a single crustal section. This model better explains the structural complexity of Ios than a conventional metamorphic core complex framework, where deformation is partitioned across multiple structures and inherited fabrics, playing a major role in controlling strain localization (Whitney et al., 2004). This highlights the importance of integrating solid, robust field observations with geochronological and thermochronological constraints when reconstructing the tectonic evolution of the Cyclades.

Summary

This thesis integrates new field observations with in-situ white mica $^{87}\text{Rb}/^{87}\text{Sr}$ geochronology to reassess the structural and tectonometamorphic evolution of Ios, with emphasis on the nature of the contact between the Cycladic Basement (CB) and Cycladic Blueschist Unit (CBU). Field observations confirm the presence of a pervasive domal schistose (S_2) foliation within the schists of both the CB and CBU, and a gneissic foliation (S_2) within the orthogneiss of the CB. These fabrics are associated with a well-developed north-south trending stretching lineation (L_1). Superimposed on this fabric are later sets of folding that affects all lithologies. Two principal fold generations are recognized: (1) early tight to isoclinal folds that are commonly rootless and largely transposed during the development of the S_2 foliation, and (2) later open to upright folds that refold the regional S_2 fabrics and earlier fold structures. Folding produced an axial planar crenulation cleavage (S_3), which is pervasive across the island that crenulates and locally transposes the earlier S_2 foliation. Within both the CB and CBU, these

folds are consistently developed, and contacts themselves are folded, indicating that deformation was not partitioned between units. The development of the axial planar cleavage, with folding of all lithologies and the CB-CBU contact together, demonstrates that folding post-dates island wide shearing. As a result, opposing shear sense indicators observed within outcrop, are interpreted to reflect rotation, and overprinting of earlier fabrics during folding, rather than recording discrete, bidirectional shear events. In-situ $^{87}\text{Rb}/^{87}\text{Sr}$ geochronology on white mica yields ages of c. 20 Ma for the CB, and slightly older ages c. 30 Ma for the CBU. These ages are consistent with previously published data for the region and are interpreted to record deformation-related recrystallization during greenschist facies overprint. White mica grains both parallel and oblique to foliation yield indistinguishable ages, suggesting that these fabrics formed during a single, progressive deformation event rather than recording multiple generations of deformation. Ductile deformation and folding occurred prior to Miocene cooling and exhumation associated with Aegean extension, implying that the CB and CBU were already juxtaposed prior to these events, and shared a coeval tectonic history before final exhumation. Assembling these observations shows Ios does not conform to the architecture of a typical metamorphic core complex. Instead of recording deformation along a single, throughgoing detachment, the island preserves evidence for distributed deformation accommodated across multiple temporally distinct structures. Within the broader Cyclades, the structural characteristics of Ios are more consistent with those of a metamorphic gneiss dome, in which deformation is distributed and accommodated through doming, folding, and progressive overprinting, rather than along a discrete detachment. Ios could have been exhumed within the hinge zone of the north-directed Naxos detachment and south-directed Santorini detachment, with the principal detachment having been eroded away and stratigraphically above the present-day exposure of the island. This

study contributes to an evolving understanding of Cycladic tectonics by demonstrating that structural interpretations based solely on macroscopic similarities to MCCs may oversimplify the complexity of deformation. The integration of detailed field observations with microstructural analysis and in-situ $^{87}\text{Rb}/^{87}\text{Sr}$ geochronology provides a more robust framework for distinguishing between deformation mechanisms and timing relationships. In particular, the recognition of post-kinematic folding, the distinction between S-C fabrics and axial planar crenulation cleavage, and the role of inherited structures highlight the importance of multi-scale analysis when reconstructing tectonic histories.

Ultimately, this thesis provides an alternative perspective with new field identifications that refine the tectonic history of the island, calling into question previous interpretations based on the new field work conducted. Due to the conflicting debates surrounding the history of Ios, future work should focus on integrating thermochronological datasets, detailed microstructural analysis of deformation mechanisms, and region scale correlations with adjacent islands (Syros), to further constrain the timing and processes of exhumation. Such efforts will be critical for resolving the tectonic position of Ios within the Aegean domain and refining broader models of extensional orogenesis in the Cyclades.

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Appendix

Table S1. Locations of samples and microstructural observations from Ios, Greece

sample	rock name	Zone	UTM E	UTM N	structural location	geographic location	modal %										notes
							Qz	Cal	Ms	Bt	Chl	Fsp	Amp	Dol	acc min	oxides	
CS24-03A (north)	orthogneiss	35	347548	4063603	CB- headland shear zone	slightly south of milopotas beach along coast	30		35	8		10			grt- 15	opaque- 2	Kfs occurs as subhedral porphyroclasts (~0.5–1 mm) with irregular grain boundaries and inclusions of Grt ± Wm. Some Kfs grains exhibit Carlsbad twinning and are Or. The Wm-rich foliation wraps around Kfs porphyroclasts. Grt occurs as very fine-grained (vfg), subhedral grains and appears to post-date development of the principal foliation. Qz exhibits undulose extinction and irregular to locally sutured grain boundaries. Fine-grained recrystallized Qz is concentrated within strain shadows adjacent to Kfs porphyroclasts. Wm-rich layers are heterogeneous and contain variable proportions of Qz ± Fsp. Brown, locally developed suture/seams may represent sites of pressure solution and dissolution-precipitation. Two generations of white mica are recognized: Wm ₁ defines the principal foliation (S), whereas Wm ₂ occurs at an angle to S ₁ and is interpreted to post-date development of the main fabric.
CS24-03B (east)	orthogneiss	35	347548	4063603	CB- headland shear zone	slightly south of milopotas beach along coast	45		30	5		10			grt- 7 ap- tr	tr (vfg)-3	Thin section cut perpendicular to the lineation. Kfs occurs as subhedral porphyroclasts (~0.5 mm) with irregular grain boundaries and relatively homogeneous internal textures, showing minimal alteration or compositional zoning. Small, high-relief mineral inclusions within Kfs are interpreted as Ap(?).
CS24-04	garnet mica schist	35	347546	4063606	CB- headland shear zone	slightly south of milopotas beach along coast	35		47	2		8			grt- 8, zr-tr, ap- tr		Mylonitic fabric with significant grain-size reduction of Qz, while relict Kfs (Mc) augen porphyroclasts are preserved and wrapped by the main Wm foliation. Qz exhibits undulose extinction and is dynamically recrystallized, with relatively regular to locally lobate grain boundaries. Recrystallization is characterized by weak-moderate bulging recrystallization (BLG), subgrain rotation (SGR), and minor grain-boundary migration (GBM). Some Qz subgrains display possible chessboard extinction, and locally developed triple junctions are present within the recrystallized quartz matrix. Grt occurs as subhedral grains with irregular rims and possible weak replacement by Chl(?). The Wm foliation wraps around some Grt grains, and subtle internal zoning toward grain cores may be present. An unidentified fine-grained, high-relief mineral also occurs. Kfs (Mc) porphyroclasts reach up to ~6 mm and are relatively inclusion-poor, with recrystallized Qz concentrated along grain boundaries and strain-shadow margins. The foliation also wraps around Fsp porphyroclasts associated with Ep ± Czo, and small elongate prismatic Ap grains occur as accessory phases. Isolated shear bands are locally developed and may contribute to spatial variations in the grain size and distribution of Qz subgrains and recrystallized grains.
CS24-05	mica schist	35	347303	4063696	CB- headland shear zone	slightly south of milopotas beach along coast	40		45	3					grt- 10 ti-tr, zr- tr, ap- tr	(opaque)- 2	Sample dominated by Qz and Wm, with larger Wm first developed within a strongly foliated, grain-size-reduced matrix. Qz exhibits significant grain-size reduction and undulose extinction, with larger subgrains up to ~1 mm surrounded by finer recrystallized grains (<0.5 mm). Dynamic recrystallization is dominated by subgrain rotation (SGR), producing relatively equigranular recrystallized Qz with locally straight grain boundaries. Grt is rare. Wm forms relatively homogeneous, foliation-parallel layers up to ~2 mm thick. Two generations of white mica are recognized: Wm ₁ defines the principal foliation and locally forms mica fish, whereas Wm ₂ comprises younger grains oriented oblique to the main foliation. Cleavage is well developed within individual Wm grains forming the mica-rich bands.

CS24-06	mica schist	35	347303	4063696	CB- headland shear zone	slightly south of milopotas beach along coast	43	32	25	ti- tr	rt- Tr	Larger Fsp porphyroclasts locally display sigmoidal geometries within the mylonitic fabric. Fsp grains commonly exhibit simple twinning, with some grains displaying two apparent cleavage directions at approximately 90°; mineral identification as Fsp(?) should remain tentative where diagnostic twinning or other optical characteristics are absent. A weak S-C fabric and/or weak cleavage is locally developed. Grt is rare to absent in this sample, limiting the ability to establish the relative timing of Grt growth with respect to development of the mylonitic fabric.	
CS24-07	garnet mica schist	35	349721	4066776	CB	central island	30	45	10	tr	5	grt- 10	Mylonitic fabric containing large Grt and Fsp porphyroclasts within a Wm-rich foliated matrix. Dark brown alteration locally infills fractures and is also concentrated along the Wm foliation. Grt porphyroclasts are fractured, with the foliation wrapping around grain margins, and fractures locally infilled by Ep ± Chl. Minor Chl alteration also occurs along some Grt margins. Qz occurs as larger relict subgrains surrounded by finer dynamically recrystallized grains. One Grt porphyroclast is strongly disrupted and fragmented, with separated grain domains suggesting significant brittle to brittle-ductile deformation.
CS24-08	orthogneiss	35	353840	4067213	CB- headland shear zone	Psathi (east island below contact)	25	25	30	grt- 20	opaque- tr	Fine, discontinuous Wm-rich bands define a weak foliation throughout the sample. Blochy, speckled to shiny patches are interpreted as Ser(?) alteration, locally forming diffuse mica-rich domains. Fsp grains have irregular grain boundaries, abundant mineral inclusions, and significant brittle fracturing. Qz is concentrated within strain shadows adjacent to Fsp porphyroclasts, while the Wm foliation wraps around the porphyroclasts. Two generations of white mica are recognized: Wm ₁ defines the principal foliation as fine, discontinuous bands, whereas Wm ₂ occurs as later, more randomly oriented or oblique grains. Diffuse Ser(?) rich alteration bands locally overprint the primary fabric.	

CS24-09	orthogneis s	35	354001	4067364	CB- headland shear zone	Psathi (east island below contact)	30											grt- 12, il- tr, ap- tr	opaque- 3	A well-developed Wm foliation wraps around euhedral to subhedral Grt porphyroblasts up to ~2 mm. Grt contains fine-grained inclusions, including Wm, Qz, and possible Rt ± Zr; and some grains are internally fractured with secondary mineral infill along fractures. Grt grains are locally rounded to subhedral, whereas additional isotropic, high-relief, speckled grains of less well-defined shape are present and remain unidentified. Fps occurs as relatively intact subhedral porphyroclasts with irregular grain boundaries, minor fracturing, and locally developed Carlsbad twinning. Possible Ap(?) inclusions occur within some Fsp grains. Qz is pervasively grain-size reduced, exhibits undulose extinction, and records dynamic recrystallization dominated by subgrain rotation (SGR) with minor bulging recrystallization (BLG). Qz also occurs as inclusions within Grt and in strain-shadow domains adjacent to porphyroblasts. Relatively thick Wm-rich bands define the main foliation and locally appear to overprint or truncate Qz-rich domains. Possible Bt(?) occurs within Qz strain shadows adjacent to Grt. Very fine-grained, pale blue phases in PPL may represent Zm(?) or another accessory phase, but identification is uncertain.
CS24-10	calcite mica schist	35	347298	4070175	CBU	central CBU unit	10	50	20	5	10								opaque- 5	Subhedral to anhedral Cal is locally altered, displaying a speckled appearance and burnt yellow–orange interference colours. Fsp porphyroclasts (~2 nm) have irregular grain boundaries, locally exhibit simple twinning, and contain mineral inclusions and fractures; some grains also preserve a weak internal ductile fabric. Wm defines the main foliation and shows minor Chl(?) alteration, with locally blue anomalous interference colours under XPL. Qz occurs within strain shadows adjacent to Fsp porphyroclasts and records dynamic recrystallization through bulging recrystallization (BLG) and subgrain rotation (SGR). A well-formed, diamond-shaped Opq phase is present. Cal appears to post-date Fsp, locally overprinting or replacing Fsp porphyroclasts. The mica foliation is crenulated, with deformation of Wm producing brighter interference colours, local loss of obvious cleavage, and possible recrystallization. Fine-grained recrystallized Fsp(?) also occurs locally within fractures in larger Fsp porphyroclasts. Trace Ttn and Chl are present.
CS24-11	orthogneis s	35	346351	4067478	CBU- west SCSZ	western island along contact	30		15		30	15						ep- 5	opaque- 5, zr-tr	Strong Ser alteration affects Fsp, with Pl locally intensely altered and largely replaced by fine-grained sericite. Two generations of white mica are recognized: Wm forms thin, foliation-defining layers, whereas Wm2 comprises more euhedral grains with apparent cleavage oriented at a high angle to, and locally nearly perpendicular to, the main foliation. The Wm foliation wraps around relict Fsp porphyroclasts. Qz exhibits significant grain-size reduction and dynamic recrystallization, with recrystallized grains up to ~0.2 mm and larger subgrains up to ~0.5 mm. Recrystallization is dominated by subgrain rotation (SGR) with minor bulging recrystallization (BLG), and some subgrains display chessboard extinction. Fsp porphyroclasts are heterogeneous and locally associated with incompletely recrystallized Qz, all enclosed by the mica-rich foliation. Ep ± Czo are present as accessory phases. Pressure-solution seams occur locally but are less developed than in sample 15, with dark seams that are thinner and less laterally continuous.

CS24-12A (north)	orthogneis s	35	354897	4058656	CB	north of magganari	35			35	5	25	zr- tr, ti- tr	opaque- 5	Very coarse Fsp porphyroclasts (6–7 mm) occur within a matrix of dynamically recrystallized Qz, with recrystallization predominantly occurring through subgrain rotation (SGR). Fsp porphyroclasts are blocky to anhedral, locally fractured, and contain fractures infilled by Wm. Qz is inequigranular and exhibits variable degrees of grain-size reduction. Wm defines a weak foliation within thin, discontinuous layers, whereas a second generation (Wm ₂) comprises grains oriented oblique to the main foliation. Fsp porphyroclasts contain fine-grained Qz ± Pl inclusions with variable to random orientations. Pl locally exhibits subgrain development and recrystallization, consistent with relatively high-temperature crystal-plastic deformation. Fine-grained Ab occurs as recrystallized domains within larger Fsp porphyroclasts. Particularly well-developed Pl subgrains occur in the lower-left portion of the thin section, away from point A.
CS24-12B (east)	orthogneis s	35	354897	4058656	CB	north of magganari	35			20	5	35	rt- tr	opaque- 5	perpendicular cut to previous sample. Same features
CS24-13	orthogneis s	35	354899	4058659	CB	north of magganari	45			40	10		zr- tr, ti- tr	opaque- 5	Protomylonitic fabric characterized by fine-grained, altered Wm-rich layers with associated dark alteration. A second fine-grained, fibrous phyllosilicate with lower interference colours than Ms is present and may represent Chl(?) or another mica/phyllosilicate phase; identification remains uncertain. Fine-grained, high-relief accessory minerals include possible Ap(?) and Ttn(?). Possible euhedral to hexagonal Grt(?) grains are also present. An additional medium-relief phase displays a speckled appearance in PPL and remains dark under XPL; its identity is uncertain and may represent an isotropic mineral rather than Grt. A low-relief isotropic-appearing phase is also present but remains unidentified; care should be taken to distinguish true isotropic behaviour from Qz observed at or near extinction.
CS24-14	orthogneis s	35	354899	4058659	CB	north of magganari	45			45	5		ap- tr	opaque- 5	Protomylonitic fabric developed throughout the sample, dominated by Wm, Qz, and Opq. Wm defines the principal foliation as thin, discontinuous bands and locally preserves relatively intact to fibrous grains. A second generation of Wm ₂ comprises generally coarser grains oriented oblique to the main foliation, suggesting growth after development of the principal fabric. Qz is dynamically recrystallized and forms a subequigranular matrix with irregular to locally lobate grain boundaries. Reddish alteration, similar to that observed in previous samples, is also present and is tentatively interpreted as Hem(?) staining.
CS24-15	garnet mica schist	35	353263	4057051	CB	magganari along coast	35			30	10	5	grt- 15, ti- tr, zr- tr	opaque- 5	Mylonitic sample with a well-developed, planar foliation defined by thick Bt ± Chl-rich layers (~1–2 mm). Bt and Chl occur together, with greenish-yellow grains locally exhibiting well-developed cleavage. Chl also occurs as unoriented grains with undulose extinction, suggesting at least some Chl may post-date development of the main foliation. Qz exhibits significant grain-size reduction and forms a relatively equigranular recrystallized matrix. Fine-grained, euhedral Grt is disseminated throughout the sample. Grt locally overprints the foliation, suggesting growth after development of the principal fabric. Dark pressure-solution seams are developed locally within the foliated matrix. Trace Ttn occurs as disseminated subhedral grains. Clt is also present within the assemblage.

CS24-16	garnet mica schist	35	353263	4057051	CB	magganari along coast	5							15	60	grt-15 opaque- 5	The sample is dominated by fine-grained Wm defining the main foliation, with widespread replacement/alteration of Wm by Chl. More euhedral Wm grains lack a preferred orientation and may represent a later generation that overprints the foliation. Subhedral Grt porphyroblasts are present, with the foliation locally wrapping around grain margins; variable textural relationships may indicate both syn- and post-kinematic Grt growth, although this remains uncertain. Qz occurs as larger relict grains surrounded by finer dynamically recrystallized grains/subgrains. An unidentified colourless mineral in PPL exhibits apparent polysynthetic, Pl-like twinning, but individual bands display relatively high birefringence and locally speckled extinction. The phase may be mica-related, but its identification remains uncertain based on these optical characteristics alone.
CS24-17	garnet mica schist	35	355156	4062118	CB	magganari along coast	35						50	5	grt- 5, zr- tr, ti-tr	Mylonitic fabric with preserved Fsp porphyroclasts up to ~5 mm, around which the Wm-rich foliation wraps. Fsp porphyroclasts are fractured and locally contain Wm inclusions. Ductilely deformed Qz wraps around the Fsp porphyroclasts and is locally drawn out into elongate, foliation-parallel layers. Qz is partially dynamically recrystallized through subgrain rotation (SGR) and bulging recrystallization (BLG), with significant development of irregular grain boundaries. Possible Qz inclusion trails are preserved around or within some Fsp porphyroclasts. Wm forms relatively homogeneous, foliation-parallel layers up to ~2 mm thick. Trace Tin occurs as disseminated grains throughout the sample. Possible Lws(?) is present but difficult to confidently identify petrographically.	
CS24-20	mica schist	35	347152	4069612	CBU	central contact in CBU	40	tr	30				20		rt- tr	opaque- 10	Significant reddish alteration, interpreted as Hem staining, occurs throughout the sample and is preferentially concentrated along the hinge zones of crenulations produced by folding of the mica-rich foliation. Qz records significant dynamic recrystallization, with extreme grain-size reduction and ~80% recrystallization. Recrystallized Qz is inequigranular and exhibits irregular to lobate grain boundaries, consistent with bulging recrystallization (BLG) and suturing, with locally developed grain-boundary migration (GBM). A single generation of white mica (Wm?) appears to define the folded/crenulated foliation.
CS24-21	orthoigneis s	35	355140	4062096	CB	central CB	45						10	40	ap- tr	opaque- 5	Orthogneiss sample dominated by Fsp, Wm, and lesser Qz. Wm defines the principal foliation as thin, discontinuous bands and locally preserves relatively intact to fibrous grains. A second generation of Wm comprises generally coarser grains oriented oblique to the main foliation, suggesting growth after development of the principal fabric. Qz is dynamically recrystallized and forms a subequigranular matrix with irregular to locally lobate grain boundaries. Reddish alteration, similar to that observed in previous samples, is also present and is tentatively interpreted as Hem(?) staining. Fsp porphyroclasts are up to 4mm in length, and display wim wrapping, as foliation

CS24-22	blueschist	35	344918	4068735	CBU	above CB-CBU contact	20	30	13	rt-3, lws- tr	opaque-4	Mylonitic texture with significant grain-size reduction of Qz, with relict Kfs (Me) augen porphyroclasts around which the foliation wraps. Qz exhibits undulose extinction but generally regular, equigranular grain boundaries, with locally developed chessboard-pattern subgrains. Qz records weak-moderate bulging recrystallization (BLG) and subgrain rotation recrystallization (SGR), with weak grain-boundary migration (GBM). Locally, recrystallized Qz forms triple junctions. Grt occurs as subhedral grains with irregular rims and possible weak replacement by Chl(?). Mica-rich foliation wraps around some Grt grains, and some grains exhibit apparent compositional zoning toward their cores. Relict Kfs (Me) porphyroclasts are up to ~6 mm and relatively inclusion-free, with recrystallized Qz concentrated along grain boundaries. Czo occurs as fine-grained, high-relief grains, whereas Ap occurs as small, elongate prismatic grains. Ep occurs as high-relief, fractured grains. Possible blueschist-facies assemblage includes fine-grained Gln. Rt occurs as fine-grained, bright red grains. An unidentified purplish, fine-grained, euhedral, approximately square mineral is also present. Possible Chl(?) is pale green, lacks obvious cleavage, and appears to replace Gln. Two generations of white mica (Wm) are recognized. Wm1 defines the main foliation, whereas Wm2 occurs at an oblique angle to the foliation. Textural relationships suggest that Gln post-dates Wm1 but pre-dates Wm2.
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Table S1. Locations of

		deformation mechanisms				microstructures		Overprinting relationships in quartz, muscovite placement in thin section, feldspar deformation				
sample	rock name	sutured	BLG	SGR	GBM	dis-precip	SC, SCC', fish, sigmoidals, wings, etc	field observations of sample (crenulation/fol/sc)	thin section observations relating to field obs	quartz/mica grain size (4mm lense in 5x)	CPO/SPO	
CS24-03A (north)	orthogneiss _s	✓		✓		✓	wm- weak SC, recrystallized quartz- slight sigmoidal structure	HSZ- axial cleavage creating orthogneiss from granite.	grt is post kinematic, with no foliation wrapping around, growing over wm layers and is not included in qtz matrix	qtz- recrystallized < 0.5mm, wm- <0.75mm	No CPO, variable colours etc.	fine grained wm drawn into foliation, with overgrown grains oriented perpendicular to foliation. fsp subhedral with some irregular grain boundaries, garnets grown over top, twinning preserved, and minor inclusions, microcracks and dark rims
CS24-03B (east)	orthogneiss _s	✓	✓	✓			wm- wavy foliation wrapping around fsp.	HSZ- axial cleavage creating orthogneiss from granite.	grt appears to be post kinematic, with no foliation wrapping around, growing over wm layers and is not included in qtz layers.	qtz- recrystallized < 0.5mm, wm - <0.75mm	No CPO, variable colours etc.	fine grained wm drawn into foliation, with overgrown grains oriented perpendicular to foliation. - fsp subhedral with some irregular grain boundaries, grt grown over top, twinning preserved, and minor inclusions, microcracks and dark rims.
CS24-04	garnet mica schist			✓			wm- thin bands disseminated weak SC, mostly wavy foliation along with quartz rich layers.	HSZ- mylonite, fsp precipitates in strain shadow of qtz porphyroblasts.	grt post kinematic, some wm grains defining foliation others at angle to it.	qtz- recrystallized <0.5mm, wm- <0.8mm	No CPO, variable colours etc.	large 4mm fsp porphyroblasts, surrounded by recrystallized qtz. Minor grt overprinting qtz. Brittle fractures within the fsp show qtz infill. wm aligned to define foliation occurring with ep. Grt overprints wm (younger than foliation).
CS24-05	mica schist	✓	✓	✓		✓	wm- nice clusters, lenticular mica fish (TTS)	HSZ- axial planar crenulation cleavage	Two generations of micas and wavy wm foliation with (crenulation) in the mica bands.	qtz- recrystallized <0.5mm, wm- up to 2mm long	No CPO.	very nice wm layers (homogeneous) defining foliation. 2 generations of mica with one defining the foliation and a younger overgrowth generation aligned at angle to foliation. No fsp porphyroblasts or grt.

CS24-06	mica schist	✓	✓	✓	✓	<p>wm- weak crenulations in small mica layers. 2nd generation of mica. That is younger than foliation, and isn't oriented with foliation. Discontinuous mica layers</p> <p>HSZ- crenulation? Yes</p> <p>Bundles/sigmoids, and significant fsp compared to qtz</p> <p>qtz- variable sizes (0.1mm to 0.5mm) of recrystallized grains, wm- up to 2mm long</p> <p>No CPO</p> <p>wm- discontinuous lenses, which are minorly altered by chl and define foliation. Fsp and qtz together, fsp within groundmass. wm overgrown on the feldspar, qtz groundmass.</p>
CS24-07	garnet mica schist		✓	✓	✓	<p>fine grained wm aligned in layers defining foliation, overgrown on recrystallized qtz groundmass. Grt are pre-syn kinematic and overgrown on fsp porphyroblasts. Fsp are being wrapped by foliation, microcracks/fracturing and fg mineral inclusions. fsp almost appears to be ductily pulled into the foliation (stretched). Large grt (2-4mm) overgrown on qtz but wrapped by wm foliation. One example of ductile fsp, having intergrowth of qtz irregular grain boundaries.</p> <p>wm- mica fish TTN. 2 generations, with the first defining foliation and the second being larger, more euhedral grains at an angle to foliation (with a few grains as porphyroblasts??)</p> <p>schist with flanking structures and rotated veining (TTN)</p> <p>grt- foliation wrapping around, pre-syn kinematic (up to 4mm)</p> <p>qtz- 0.2mm recrystallized grains, wm- up to 1mm.</p> <p>No CPO</p>
CS24-08	orthogneiss			✓	✓	<p>wm- Very thin bands disseminated grains, wavy foliation and mica fish. (TTN?)</p> <p>schistose granitoid. SC structures (TTS)</p> <p>thin, 0.1mm bands of wm, discontinuous but aligned to define foliation.</p> <p>qtz- avg 0.2mm, wm- up to 0.4mm long</p> <p>No CPO</p> <p>zr within fsp, wm alignment in discrete layers defines foliation, intense subgrain rotation recrystallization of qtz.</p>

CS24-09	orthogneiss	✓	✓	✓	✓	<p>wm- thicker mica bands, mica fish its, sigma clasts of feldspar, maybe weak SC? TTS SC structures, Some mica grains aligned at mylonitized schist angle to foliation (2nd generation)</p> <p>grt porphyroblasts, pre kinematic, euhedral to subhedral, up to 1.5mm.</p> <p>qtz- up to 0.4mm, wm- homogeneous bands up to 2mm thick and grains 1mm long.</p> <p>weak CPO</p> <p>grt porphyroblasts fractures infilled, overgrown on fsp porphyroblasts, with wm foliation wrapping it (pre-syn kinematic), fsp clasts, brittle fractured, wm in banded layers with varying thicknesses.</p>
CS24-10	calcite mica schist		✓	✓	✓	<p>wm- crenulated but discontinuous</p> <p>CBU- marble/blueschist, crenulation cleavage of S1.</p> <p>fsp porphyroblasts with mica foliation wrapping around, wm is partially altered by chl. Ductile fabric but kind of chaotic. 2 planar structures oblique to each other.</p> <p>qtz- up to 0.5mm, wm- up to 1.5mm long (aligned to define foliation in bands up to 1mm thick. 2nd generation aligned at angle to fol.</p> <p>weak CPO</p> <p>fsp and cal have interesting relationship, with cal younger, but fsp showing synkinematic internal fabric, Twinning preserved in fsp Mineral inclusions in fsp (wm, zr, ap). wm wraps around fsp porphyroblasts.</p>
CS24-11	orthogneiss	✓	✓	✓	✓	<p>wm- wavy foliation, and weak SC</p> <p>crenulation and SC (TTS) and climbing quartz showing TTN, Kink folding, high angle fracture faults in the field.</p> <p>qtz- 0.2-0.5mm, wm- foliation defining gen 1: 0.2mm, gen 2- 0.5mm and up to 0.5mm thick.</p> <p>weak CPO</p> <p>fsp porphyroblasts overprint by recrystallized qtz and some wm, wm foliation wraps around, grains are twinned, anhedral, relatively inclusion free. Fine grained wm is defining foliation, with 2nd generation of larger grains aligned at angle to foliation.</p>

CS24-12A (north)	orthogneis s				✓	wm displays wavy foliation, thin discontinuous layers and some grains (vfg) within groundmass	SOUTH-shear bands in two directions from the sample, large fsp porphyroblasts and TTS for one. Late structures are recrystallized qtz in strain shadows.	qtz- up to 0.4mm, mica- 0.4mm	weak CPO	weak wm alignment, fine bands. Large fsp porphyroblasts (4-5mm) overprinted by recrystallized qtz, fractures infilled by recrystallized wm,
CS24-12B (east)	orthogneis s				✓		SOUTH-shear bands in two directions from the sample, TTS for one. Late structures are folded and overprint.			weak wm alignment, fine bands. Large fsp porphyroblasts (4-5mm) overprinted by recrystallized qtz, fractures infilled by wm
CS24-13	orthogneis s	✓	✓	✓	✓	same sample location at 14-mica- wavy foliation with weak SC, wraps around porphyroblasts. The spot defines the contact of micaschist unit from CB, chloritoid in this sample and the OC contained shear bands much cooler than fabric in the rock (earlier mylonitic fabric)	SOUTH- chloritoid present 2mm thick bands, weak SC structures	wm defines foliation up to chessboard pattern, and smaller recrystallized grains- 0.3mm, mica- up to 0.5mm.	No CPO	wm alignment in bands with 2nd generation at angle to the foliated bands. Large subgrains of qtz (up to 1mm), fsp are not porphyroblasts, have strong alteration around rims making them appear high relief.
CS24-14	orthogneis s		✓	✓	✓	wm- defines foliation, thin bands.	Two generations of wm, minor chl in wm layers	qtz- up to 0.5mm, mica- largest grains at angle to foliation (up to 0.7mm)	No CPO	wm alignment in bands with 2nd generation at angle to the foliated bands. Large subgrains of qtz (up to 1mm), only a few feldspars which are not porphyroblasts, have strong alteration around rims making them appear high relief.
CS24-15	garnet mica schist		✓	✓	✓	wm- planar foliation/alignment	folded wm-schist, and structurally below the orthogneiss and asymmetrical crenulation cleavage	qtz- 0.5mm, wm- up to 0.7mm.	No CPO	preferred orientation in wm rich layers with a second generation at angle to foliation. Fsp porphyroblasts are within these mica layers/overgrown??? but there is weak/no foliation wrapping around, Fsp have mineral inclusions, with same preferred orientation as the S1 foliation. grt are post kinematic, over wm and has no foliation wrapping. Dark green in PPL chl

CS24-16	garnet mica schist			✓				<p>wm- aligned grains define foliation (chlorite?)</p> <p>SOUTH- folded area mica schist, asymmetrical crenulation cleavage.</p> <p>chl alt of wm, post kinematic grt, 2 gens of wm. One finer grained defining foliation. 2nd gen post foliation and larger grains.</p> <p>wm- up to 0.8mm for largest grains.</p> <p>No CPO</p> <p>More chl than previous sample, taken within same OC. Grt are post kinematic, overprinting micas and has no foliation wrapping. wm show preferred orientation with 2nd generation overgrown and at angle to foliation. fsp (twinning?)</p>
CS24-17	garnet mica schist	✓	✓	✓		✓		<p>wm- weak SC</p> <p>MSCHIST- lawsonite found. Contact between orthogneiss and schist lense.</p> <p>wm defines foliation wrapping around fsp porphyroblasts. With second generation in larger euhedral grains at angle to foliation.</p> <p>qtz- subgrains up to 0.6mm with recrystallized grains smaller; wm- 0.5mm long</p> <p>no CPO</p> <p>wm inclusions overprint fsp porphyroblast (2nd gen) and 1st gen wm foliation wrapping around, fsp are smeared out into the quartz strain shadows, ductile deformation.</p>
CS24-20	mica schist	✓	✓	✓	✓	✓		<p>wm-wavy foliation, SC? Crenulation?</p> <p>CBU- anastomosing quartz bands and sigmoidals, crenulation cleavage/axial planar cleavage.</p> <p>recrystallized quartz, and chessboard subgrain extinction patterns. Weak crenulation cleavage, intense alteration overtop so harder to tell.</p> <p>qtz- recrystallized grains 0.01mm and subgrains 0.3mm, wm- up to 1mm in length (1 clear generation of mica)</p> <p>No CPO</p> <p>alteration throughout sample makes it hard to see structures; anastomosing quartz banding, with aligned wm and cren cleavage/folding? GBM of quartz with 0.5-0.7mm subgrains and chessboard extinction.</p>
CS24-21	orthogneiss		✓	✓				<p>wm- defines foliation, thin bands.</p> <p>Two generations of wm, minor chl in wm layers</p> <p>qtz- up to 0.5mm, micas- largest grains at angle to foliation (up to 0.7mm)</p> <p>No CPO</p> <p>wm alignment in bands with 2nd generation at angle to the foliated bands. Large subgrains of qtz (up to 1mm), only a few feldspars which are not porphyroblasts, have strong alteration around rims making them appear high relief.</p>

CS24-22	blueschist				✓				fractured epidote, minor chl, rutile, opaques, elongate glaucophane defining foliation.	qtz- 0.5mm subgrains, wm up to 1mm long.	very weak CP	blueschist, smaller gln minerals. Fine grained bright red rt. There is also a purplish fine grained euhedral square mineral. Ep occurs as high relief fractured grains. Chl ls light green, lacking cleavage
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Table S2. Electron microprobe results for muscovite from los (Greece)

CS24-05 - mylonitic wm-schist (CB)																
Analysis	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SiO ₂	48.84	49.67	49.58	50.43	49.31	49.30	49.56	49.71	49.59	50.76	50.41	49.99	49.55	49.72	49.87	50.08
TiO ₂	0.71	0.71	0.69	0.88	0.71	0.73	0.64	0.52	0.61	0.47	0.83	0.81	0.69	0.88	0.68	0.87
Al ₂ O ₃	26.23	25.21	25.93	25.36	25.91	25.96	26.23	25.43	25.78	24.34	24.86	24.82	25.65	25.44	25.49	25.00
Cr ₂ O ₃	0.01	0.02	0.01	0.04	0.02	0.04	0.02	0.02	0.00	0.05	0.01	0.01	0.00	0.05	0.05	0.09
FeO	4.76	5.18	4.95	5.10	5.18	5.63	5.04	4.73	5.06	4.93	5.47	5.28	5.57	5.00	4.89	5.09
MnO	0.00	0.02	0.01	0.00	0.00	0.01	0.07	0.09	0.05	0.00	0.05	0.05	0.00	0.01	0.03	0.07
MgO	2.58	2.80	2.80	2.96	2.79	2.76	2.73	2.62	2.80	3.01	2.92	2.68	2.74	2.73	2.86	2.86
CaO	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00
Na ₂ O	0.19	0.20	0.17	0.19	0.18	0.23	0.22	0.18	0.17	0.13	0.19	0.17	0.26	0.14	0.47	0.19
K ₂ O	10.89	10.74	10.88	10.70	10.67	10.83	10.76	10.86	10.84	10.91	10.89	10.76	10.84	11.06	10.74	10.73
Totals	98.65	98.96	99.45	100.09	99.22	99.88	99.69	98.61	99.32	99.03	100.05	98.99	99.71	99.45	99.58	99.40
Si	3.36	3.40	3.38	3.41	3.37	3.36	3.37	3.41	3.38	3.47	3.42	3.42	3.38	3.39	3.39	3.41
Ti	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.04	0.04	0.04	0.05	0.03	0.04
Al	2.12	2.04	2.08	2.02	2.09	2.08	2.10	2.06	2.07	1.96	1.99	2.00	2.06	2.05	2.04	2.01
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.27	0.30	0.28	0.29	0.30	0.32	0.29	0.27	0.29	0.28	0.31	0.30	0.32	0.29	0.28	0.29
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.26	0.29	0.28	0.30	0.28	0.28	0.28	0.27	0.28	0.31	0.30	0.27	0.28	0.28	0.29	0.29
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Na	0.03	0.03	0.02	0.02	0.02	0.03	0.03	0.02	0.02	0.02	0.03	0.02	0.03	0.02	0.06	0.03
K	0.95	0.94	0.95	0.92	0.93	0.94	0.93	0.95	0.94	0.95	0.94	0.94	0.94	0.96	0.93	0.93
X _{m9}	0.49	0.49	0.50	0.51	0.49	0.47	0.49	0.50	0.50	0.52	0.49	0.47	0.47	0.49	0.51	0.50

CS24-10 - cal-wm schist (CBU)																
Analysis	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
SiO ₂	50.12	51.22	50.04	50.27	51.43	50.36	50.00	50.94	49.30	48.82	48.81	51.93	50.51	50.25	50.24	
TiO ₂	0.21	0.18	0.18	0.24	0.18	0.19	0.18	0.20	0.29	0.20	0.27	0.25	0.17	0.14	0.16	
Al ₂ O ₃	24.79	27.05	27.64	27.84	25.49	28.04	27.39	26.96	25.54	24.90	27.30	25.50	27.91	28.45	26.11	
Cr ₂ O ₃	0.07	0.04	0.03	0.02	0.02	0.03	0.03	0.04	0.05	0.03	0.02	0.05	0.06	0.07	0.04	
FeO	3.96	3.38	3.47	3.29	3.75	2.92	3.46	3.46	3.46	3.46	3.83	3.98	3.09	2.55	5.26	
MnO	0.03	0.01	0.00	0.05	0.01	0.01	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
MgO	3.13	3.21	2.92	2.79	3.15	2.86	2.90	3.10	2.99	3.00	3.36	3.49	2.82	2.67	3.08	
CaO	0.06	0.03	0.00	0.02	0.01	0.02	0.01	0.00	0.02	0.04	0.00	0.01	0.04	0.00	0.05	
Na ₂ O	0.12	0.25	0.26	0.38	0.20	0.55	0.27	0.15	0.15	0.13	0.26	0.12	0.34	0.48	0.27	
K ₂ O	10.28	10.74	10.57	10.41	10.69	10.30	10.69	10.83	10.49	10.14	10.72	10.58	10.56	10.41	9.33	
Totals	97.25	100.59	99.59	99.79	99.39	99.78	99.41	100.23	96.77	95.21	99.03	100.38	99.99	99.53	99.00	
Si	3.46	3.41	3.37	3.37	3.47	3.37	3.37	3.41	3.42	3.44	3.32	3.47	3.38	3.36	3.41	
Ti	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
Al	2.02	2.12	2.19	2.20	2.03	2.21	2.18	2.12	2.09	2.07	2.19	2.01	2.20	2.24	2.09	
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Fe	0.23	0.19	0.20	0.18	0.21	0.16	0.20	0.19	0.20	0.20	0.22	0.22	0.17	0.14	0.30	
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Mg	0.32	0.32	0.29	0.28	0.32	0.28	0.29	0.31	0.31	0.32	0.34	0.35	0.28	0.27	0.31	
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Na	0.02	0.03	0.03	0.05	0.03	0.07	0.04	0.02	0.02	0.02	0.03	0.01	0.04	0.06	0.04	
K	0.91	0.91	0.91	0.89	0.92	0.88	0.92	0.92	0.93	0.91	0.93	0.90	0.90	0.89	0.81	
X _{m9}	0.58	0.63	0.60	0.60	0.60	0.64	0.60	0.62	0.61	0.61	0.61	0.61	0.62	0.65	0.51	

CS24-12 - orthogneiss (CB)																				
Analysis	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SiO ₂	47.93	47.17	48.44	48.56	48.40	48.64	47.71	48.40	48.56	47.74	48.13	48.38	49.09	47.96	47.76	48.57	48.10	47.15	48.98	48.42
TiO ₂	0.35	0.29	0.43	0.53	0.45	0.36	0.29	0.48	0.30	0.51	0.41	0.33	0.42	0.37	0.40	0.38	0.43	0.37	0.46	0.36
Al ₂ O ₃	31.02	30.68	29.78	29.69	29.47	29.08	30.88	30.06	30.71	30.46	29.70	30.75	27.48	30.31	30.93	29.95	29.93	31.06	29.59	30.41
Cr ₂ O ₃	0.01	0.05	0.01	0.01	0.00	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.00	0.01	0.02	0.03	0.00	0.00	0.02	0.00
FeO	3.42	3.84	3.93	3.83	3.93	4.13	3.69	3.74	3.25	3.69	3.89	3.33	4.54	3.60	3.58	3.88	3.88	3.95	4.13	3.75
MnO	0.02	0.06	0.04	0.01	0.02	0.03	0.00	0.01	0.11	0.05	0.06	0.07	0.00	0.03	0.03	0.01	0.06	0.10	0.03	0.00
MgO	0.98	1.04	1.02	1.08	1.06	1.08	0.87	1.07	1.06	1.04	1.08	0.96	1.48	0.95	0.95	0.99	1.06	0.97	1.07	0.93
CaO	0.00	0.02	0.01	0.00	0.01	0.00	0.00	0.09	0.01	0.00	0.04	0.02	0.05	0.02	0.00	0.01	0.01	0.05	0.00	0.04
Na ₂ O	0.08	0.11	0.10	0.09	0.08	0.06	0.09	0.14	0.04	0.12	0.09	0.08	0.08	0.14	0.10	0.10	0.10	0.09	0.08	0.09
K ₂ O	11.19	10.78	11.22	10.78	10.56	10.91	11.25	10.91	11.50	11.20	11.19	11.15	10.73	11.02	11.11	11.28	11.24	10.05	11.12	11.20
Totals	99.46	98.50	99.43	99.05	98.47	98.78	99.25	99.38	100.01	99.29	99.06	99.55	98.34	98.87	99.35	99.64	99.27	98.26	99.94	99.65
Si	3.24	3.23	3.28	3.29	3.30	3.32	3.24	3.27	3.26	3.24	3.28	3.26	3.37	3.26	3.23	3.28	3.27	3.22	3.30	3.27
Ti	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Al	2.47	2.47	2.38	2.37	2.37	2.34	2.47	2.40	2.43	2.44	2.38	2.44	2.22	2.43	2.47	2.39	2.40	2.50	2.35	2.42
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.19	0.22	0.22	0.22	0.22	0.24	0.21	0.21	0.18	0.21	0.22	0.19	0.26	0.20	0.20	0.22	0.22	0.23	0.23	0.21
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Mg	0.10	0.11	0.10	0.11	0.11	0.11	0.09	0.11	0.11	0.10	0.11	0.10	0.15	0.10	0.10	0.10	0.11	0.10	0.11	0.09
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
K	0.96	0.94	0.97	0.93	0.92	0.95	0.97	0.94	0.99	0.97	0.97	0.96	0.94	0.96	0.96	0.97	0.97	0.87	0.96	0.96
X _{avg}	0.34	0.33	0.32	0.33	0.32	0.32	0.30	0.34	0.37	0.33	0.33	0.34	0.37	0.32	0.32	0.31	0.33	0.30	0.32	0.31

CS24-16 - grt-wm schist (CB)														
Analysis	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SiO ₂	46.53	45.98	46.74	46.90	46.76	47.06	46.98	46.62	47.12	47.05	50.55	47.20	47.01	46.03
TiO ₂	0.06	0.05	0.07	0.05	0.05	0.05	0.07	0.04	0.10	0.05	0.23	0.03	0.06	0.05
Al ₂ O ₃	39.10	37.94	39.81	40.14	39.93	39.71	38.34	40.09	39.49	39.42	28.63	39.39	39.38	38.96
Cr ₂ O ₃	0.11	0.13	0.10	0.11	0.09	0.09	0.13	0.15	0.16	0.08	0.04	0.10	0.13	0.08
FeO	0.29	0.31	0.23	0.21	0.22	0.23	0.43	0.25	0.24	0.26	1.77	0.27	0.27	0.30
MnO	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.01	0.00	0.00	0.00	0.00	0.00
MgO	0.24	0.17	0.27	0.12	0.27	0.30	0.37	0.12	0.29	0.22	3.33	0.35	0.24	0.20
CaO	0.21	0.24	0.17	0.20	0.20	0.18	0.17	0.17	0.16	0.21	0.01	0.15	0.18	0.17
Na ₂ O	6.95	6.80	7.15	7.31	7.20	6.92	6.54	7.22	7.13	7.04	0.67	7.18	7.00	6.73
K ₂ O	0.85	0.60	0.90	0.58	0.92	1.07	1.22	0.72	0.93	0.99	9.95	0.78	0.96	1.00
Totals	99.06	96.82	100.13	100.32	100.34	100.31	98.99	100.08	100.33	100.02	99.73	100.14	99.92	98.22
Si	3.00	3.03	2.98	2.98	2.98	3.00	3.04	2.98	3.00	3.01	3.36	3.01	3.01	3.00
Ti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
Al	2.97	2.95	2.99	3.01	3.00	2.98	2.92	3.01	2.96	2.97	2.24	2.96	2.97	2.99
Cr	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00
Fe	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.10	0.01	0.01	0.02
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.02	0.02	0.03	0.01	0.03	0.03	0.04	0.01	0.03	0.02	0.33	0.03	0.02	0.02
Ca	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01
Na	0.87	0.87	0.88	0.90	0.89	0.85	0.82	0.89	0.88	0.87	0.09	0.89	0.87	0.85
K	0.07	0.05	0.07	0.05	0.07	0.09	0.10	0.06	0.08	0.08	0.84	0.06	0.08	0.08
X _{avg}	0.60	0.49	0.68	0.50	0.68	0.70	0.61	0.46	0.69	0.60	0.77	0.70	0.61	0.54

CS24-20 - grt-wm schist (CBU)																				
Analysis	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15					
SiO ₂	51.40	50.47	53.58	49.20	52.08	49.67	103.17	50.53	102.90	50.29	50.30	51.91	51.52	49.64	52.86					
TiO ₂	0.12	0.22	0.07	0.23	0.16	0.08	0.01	0.20	0.01	0.20	0.23	0.18	0.11	0.23	0.15					
Al ₂ O ₃	25.61	28.39	22.62	28.30	24.48	21.61	0.01	28.28	0.00	28.18	28.49	25.57	23.79	29.10	24.06					
Cr ₂ O ₃	0.09	0.11	0.01	0.07	0.15	0.09	0.00	0.10	0.01	0.16	0.08	0.06	0.09	0.13	0.03					
FeO	2.68	2.23	3.32	2.03	2.93	2.17	0.05	2.03	0.08	2.02	2.09	2.61	2.72	2.02	3.02					
MnO	0.01	0.03	0.07	0.00	0.00	0.02	0.00	0.04	0.01	0.01	0.00	0.01	0.00	0.02	0.02					
MgO	3.55	3.09	4.43	2.86	3.77	3.66	0.00	3.11	0.00	3.15	3.15	3.92	3.94	2.82	4.12					
CaO	0.04	0.01	0.03	0.02	0.00	0.03	0.02	0.00	0.00	0.02	0.00	0.02	0.02	0.01	0.00					
Na ₂ O	0.14	0.43	0.05	0.36	0.06	0.02	0.00	0.47	0.00	0.51	0.47	0.20	0.07	0.39	0.04					
K ₂ O	10.06	9.88	10.57	9.98	9.80	6.80	0.03	9.87	0.02	9.96	9.94	9.89	10.46	9.26	10.44					
Totals	98.2	99.4	99.2	97.6	98.0	88.8	108.4	99.2	108.2	99.0	99.3	98.9	97.2	98.2	99.3					
Si	3.48	3.37	3.60	3.35	3.53	3.66	5.50	3.38	5.50	3.37	3.36	3.48	3.54	3.34	3.55					
Ti	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01					
Al	2.04	2.23	1.79	2.27	1.96	1.87	0.00	2.23	0.00	2.23	2.24	2.02	1.92	2.31	1.90					
Cr	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00					
Fe	0.15	0.12	0.19	0.12	0.17	0.13	0.00	0.11	0.00	0.11	0.12	0.15	0.16	0.11	0.17					
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Mg	0.36	0.31	0.44	0.29	0.38	0.40	0.00	0.31	0.00	0.31	0.31	0.39	0.40	0.28	0.41					
Ca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Na	0.02	0.06	0.01	0.05	0.01	0.00	0.00	0.06	0.00	0.07	0.06	0.03	0.01	0.05	0.01					
K	0.87	0.84	0.91	0.87	0.85	0.64	0.00	0.84	0.00	0.85	0.85	0.85	0.92	0.80	0.89					
X _{avg}	0.70	0.71	0.70	0.71	0.70	0.75	0.00	0.73	0.00	0.74	0.73	0.73	0.72	0.71	0.71					
CS24-21 - orthogneiss (CB)																				
Analysis	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
SiO ₂	47.93	48.17	47.43	47.63	47.70	47.98	48.26	47.68	47.92	47.60	49.91	48.35	48.53	48.06	47.93	47.88	47.78	48.01	48.11	48.21
TiO ₂	1.37	0.87	1.03	1.12	1.32	1.35	0.99	1.34	1.17	0.82	1.11	1.15	1.34	1.27	0.79	1.05	1.31	1.30	1.41	0.99
Al ₂ O ₃	31.41	31.83	30.73	31.72	31.27	31.42	31.57	31.88	31.67	30.76	30.89	30.45	30.71	31.29	31.90	31.96	31.16	31.14	31.01	31.07
Cr ₂ O ₃	0.03	0.03	0.01	0.00	0.00	0.02	0.00	0.01	0.01	0.06	0.01	0.00	0.05	0.01	0.02	0.03	0.02	0.01	0.01	0.03
FeO	2.19	1.70	3.03	2.09	1.93	1.80	2.01	1.88	2.05	2.21	1.77	2.06	2.28	2.10	2.02	2.14	2.10	2.14	2.15	1.76
MnO	0.00	0.01	0.00	0.00	0.02	0.01	0.06	0.01	0.04	0.00	0.03	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
MgO	1.31	1.32	1.27	1.24	1.23	1.25	1.31	1.29	1.22	1.30	1.09	1.42	1.38	1.33	1.15	1.17	1.29	1.20	1.16	1.34
CaO	0.00	0.03	0.07	0.00	0.01	0.03	0.06	0.00	0.03	0.01	0.05	0.04	0.01	0.02	0.03	0.02	0.00	0.00	0.00	0.02
Na ₂ O	0.11	0.06	0.12	0.15	0.12	0.09	0.06	0.13	0.14	0.13	0.11	0.14	0.17	0.15	0.14	0.15	0.13	0.10	0.10	0.07
K ₂ O	11.23	11.46	10.65	11.26	11.11	11.29	11.38	11.27	11.33	10.86	10.73	11.10	11.18	11.41	11.05	11.26	11.21	11.35	11.40	11.42
Totals	100.00	99.97	98.82	99.70	99.20	99.73	100.19	99.97	100.06	98.24	100.22	99.21	100.14	100.13	99.53	100.15	99.49	99.73	99.84	99.41
Si	3.20	3.22	3.22	3.20	3.21	3.21	3.22	3.19	3.20	3.24	3.30	3.26	3.24	3.21	3.21	3.20	3.21	3.22	3.23	3.24
Ti	0.07	0.04	0.05	0.06	0.07	0.07	0.05	0.07	0.06	0.04	0.06	0.06	0.07	0.06	0.04	0.05	0.07	0.07	0.07	0.05
Al	2.47	2.50	2.46	2.51	2.48	2.48	2.48	2.51	2.50	2.47	2.41	2.42	2.42	2.47	2.52	2.51	2.47	2.46	2.45	2.46
Cr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fe	0.12	0.09	0.17	0.12	0.11	0.10	0.11	0.11	0.11	0.13	0.10	0.12	0.13	0.12	0.11	0.12	0.12	0.12	0.12	0.10
Mn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mg	0.13	0.13	0.13	0.12	0.12	0.12	0.13	0.13	0.12	0.13	0.11	0.14	0.14	0.13	0.11	0.12	0.13	0.12	0.12	0.13
Ca	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Na	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01
K	0.96	0.98	0.92	0.96	0.95	0.96	0.97	0.96	0.97	0.94	0.91	0.95	0.95	0.97	0.94	0.96	0.96	0.97	0.97	0.98
X _{avg}	0.52	0.58	0.43	0.51	0.53	0.55	0.54	0.55	0.52	0.51	0.52	0.55	0.52	0.53	0.50	0.49	0.52	0.50	0.49	0.58

* All data normalized to 11 oxygen

Table S3.1 Analytical results for in situ ⁸⁷Rb/⁸⁶Sr geochronology from the the white mica within CB and CBU samples

Sample Number	Rock Name	Analysis	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
CS24-05	mylonitized wm-schist (CB)	CS24-05-1	179.56	9.9	46.93	1.085	0.749	0.009	0.50
CS24-05	mylonitized wm-schist (CB)	CS24-05-2	179.14	5.8	80.72	1.911	0.766	0.016	0.38
CS24-05	mylonitized wm-schist (CB)	CS24-05-3	179.88	4.2	110.65	2.456	0.774	0.017	0.48
CS24-05	mylonitized wm-schist (CB)	CS24-05-4	183.79	2.9	161.91	4.687	0.787	0.019	0.58
CS24-05	mylonitized wm-schist (CB)	CS24-05-5	176.85	5.8	78.83	1.721	0.763	0.015	0.08
CS24-05	mylonitized wm-schist (CB)	CS24-05-6	179.87	4.5	105.24	3.399	0.779	0.019	0.55
CS24-05	mylonitized wm-schist (CB)	CS24-05-7	201.86	2.5	210.88	6.000	0.802	0.024	0.53
CS24-05	mylonitized wm-schist (CB)	CS24-05-8	187.26	4.0	121.99	2.643	0.776	0.020	0.45
CS24-05	mylonitized wm-schist (CB)	CS24-05-9	184.78	3.2	149.31	3.712	0.790	0.022	0.58
CS24-05	mylonitized wm-schist (CB)	CS24-05-10	186.58	2.8	170.27	3.971	0.792	0.020	0.36
CS24-05	mylonitized wm-schist (CB)	CS24-05-11	189.86	2.8	173.95	4.323	0.779	0.020	0.41
CS24-05	mylonitized wm-schist (CB)	CS24-05-12	175.48	8.6	52.48	1.582	0.751	0.011	0.27
CS24-05	mylonitized wm-schist (CB)	CS24-05-13	189.83	3.6	137.02	3.343	0.800	0.019	0.56
CS24-05	mylonitized wm-schist (CB)	CS24-05-14	185.61	3.4	141.14	4.034	0.780	0.024	0.69
CS24-05	mylonitized wm-schist (CB)	CS24-05-15	183.06	4.1	115.98	2.377	0.772	0.014	0.31
CS24-05	mylonitized wm-schist (CB)	CS24-05-16	174.16	5.8	77.24	1.727	0.758	0.012	0.14
CS24-05	mylonitized wm-schist (CB)	CS24-05-17	179.64	4.8	97.65	2.295	0.777	0.018	0.54
CS24-05	mylonitized wm-schist (CB)	CS24-05-18	189.43	4.2	116.04	2.904	0.786	0.018	0.35
CS24-05	mylonitized wm-schist (CB)	CS24-05-19	180.88	5.1	91.99	1.876	0.771	0.017	0.68
CS24-05	mylonitized wm-schist (CB)	CS24-05-20	183.77	4.7	100.82	1.879	0.780	0.016	0.58
CS24-05	mylonitized wm-schist (CB)	CS24-05-21	176.30	5.8	79.00	1.735	0.748	0.015	0.47
CS24-05	mylonitized wm-schist (CB)	CS24-05-22	188.01	4.3	113.41	2.817	0.783	0.019	0.39
CS24-05	mylonitized wm-schist (CB)	CS24-05-23	180.12	4.0	115.51	2.496	0.783	0.017	0.39
CS24-05	mylonitized wm-schist (CB)	CS24-05-24	185.99	4.3	110.98	2.363	0.787	0.019	0.56
CS24-05	mylonitized wm-schist (CB)	CS24-05-25	187.37	4.1	119.68	2.256	0.779	0.017	0.57
CS24-05	mylonitized wm-schist (CB)	CS24-05-26	186.06	3.4	140.09	3.188	0.791	0.020	0.48
CS24-05	mylonitized wm-schist (CB)	CS24-05-27	179.91	7.7	60.08	1.269	0.755	0.013	0.39
CS24-05	mylonitized wm-schist (CB)	CS24-05-28	189.78	3.9	126.53	3.213	0.782	0.019	0.38
CS24-05	mylonitized wm-schist (CB)	CS24-05-29	187.49	2.5	192.17	5.865	0.801	0.024	0.46
CS24-05	mylonitized wm-schist (CB)	CS24-05-30	173.80	11.3	39.63	0.837	0.749	0.011	0.19
CS24-05	mylonitized wm-schist (CB)	CS24-05-31	183.76	5.5	86.56	2.352	0.763	0.015	0.45
CS24-05	mylonitized wm-schist (CB)	CS24-05-32	192.57	2.9	170.84	4.628	0.817	0.024	0.44
CS24-05	mylonitized wm-schist (CB)	CS24-05-33	182.51	8.0	59.45	1.339	0.754	0.015	0.36
CS24-05	mylonitized wm-schist (CB)	CS24-05-34	176.46	3.8	121.30	3.239	0.782	0.020	0.65
CS24-05	mylonitized wm-schist (CB)	CS24-05-35	190.32	3.5	141.73	3.567	0.795	0.022	0.69
CS24-05	mylonitized wm-schist (CB)	CS24-05-36	189.75	3.6	137.90	2.750	0.781	0.018	0.37
CS24-05	mylonitized wm-schist (CB)	CS24-05-37	179.16	8.0	57.98	1.064	0.749	0.013	0.46
CS24-05	mylonitized wm-schist (CB)	CS24-05-38	189.39	2.9	166.57	4.138	0.790	0.023	0.50
CS24-05	mylonitized wm-schist (CB)	CS24-05-39	171.37	4.6	96.71	1.959	0.782	0.018	0.57
CS24-05	mylonitized wm-schist (CB)	CS24-05-40	178.07	7.0	66.00	1.218	0.760	0.013	0.31
CS24-05	mylonitized wm-schist (CB)	CS24-05-41	171.42	6.2	71.38	1.603	0.760	0.012	0.29
CS24-05	mylonitized wm-schist (CB)	CS24-05-42	166.18	4.4	98.78	3.395	0.764	0.011	0.37
CS24-05	mylonitized wm-schist (CB)	CS24-05-43	197.61	2.6	199.70	4.861	0.797	0.023	0.63
CS24-05	mylonitized wm-schist (CB)	CS24-05-44	182.30	4.8	98.79	2.341	0.768	0.014	0.40
CS24-05	mylonitized wm-schist (CB)	CS24-05-45	232.91	4.7	130.30	2.732	0.768	0.017	0.39
CS24-05	mylonitized wm-schist (CB)	CS24-05-46	179.16	4.8	97.51	2.412	0.775	0.015	0.31
CS24-05	mylonitized wm-schist (CB)	CS24-05-47	189.32	2.4	211.67	5.900	0.808	0.023	0.46
CS24-05	mylonitized wm-schist (CB)	CS24-05-48	183.77	4.2	114.15	2.757	0.777	0.016	0.02
CS24-05	mylonitized wm-schist (CB)	CS24-05-49	186.10	3.1	157.30	3.934	0.793	0.021	0.33
CS24-05	mylonitized wm-schist (CB)	CS24-05-50	188.73	3.7	133.14	3.088	0.781	0.018	0.38
CS24-05	mylonitized wm-schist (CB)	CS24-05-51	183.37	6.0	79.12	1.818	0.757	0.016	0.30
CS24-05	mylonitized wm-schist (CB)	CS24-05-52	189.64	3.6	139.13	4.092	0.783	0.020	0.56
CS24-05	mylonitized wm-schist (CB)	CS24-05-53	178.70	4.5	104.07	2.813	0.764	0.019	0.52
CS24-05	mylonitized wm-schist (CB)	CS24-05-54*	173.06	10.4	43.22	0.965	0.761	0.012	0.21
CS24-05	mylonitized wm-schist (CB)	CS24-05-55	186.76	3.7	130.08	3.141	0.772	0.016	0.36
CS24-05	mylonitized wm-schist (CB)	CS24-05-56	180.99	4.8	98.73	1.954	0.768	0.015	0.58
CS24-05	mylonitized wm-schist (CB)	CS24-05-57	188.76	5.7	86.51	2.184	0.765	0.013	0.48
CS24-05	mylonitized wm-schist (CB)	CS24-05-58	186.77	5.2	94.16	2.017	0.767	0.012	0.10
CS24-05	mylonitized wm-schist (CB)	CS24-05-59	192.93	4.0	124.21	2.837	0.793	0.019	0.46
CS24-05	mylonitized wm-schist (CB)	CS24-05-60	199.69	4.1	129.06	3.022	0.777	0.018	0.56
CS24-05	mylonitized wm-schist (CB)	CS24-05-61	200.53	3.4	156.11	3.432	0.782	0.018	0.38
CS24-05	mylonitized wm-schist (CB)	CS24-05-62	187.00	3.3	146.24	3.265	0.791	0.021	0.69
CS24-05	mylonitized wm-schist (CB)	CS24-05-63	177.44	5.6	82.56	1.445	0.769	0.011	0.26
CS24-05	mylonitized wm-schist (CB)	CS24-05-64*	164.68	13.4	32.20	0.829	0.741	0.010	0.13
CS24-05	mylonitized wm-schist (CB)	CS24-05-65	187.13	4.0	121.73	1.930	0.777	0.016	0.35
CS24-05	mylonitized wm-schist (CB)	CS24-05-66	184.81	5.8	83.95	2.187	0.760	0.014	0.41
CS24-05	mylonitized wm-schist (CB)	CS24-05-67	168.33	11.8	37.14	0.893	0.751	0.011	0.38
CS24-05	mylonitized wm-schist (CB)	CS24-05-68	167.38	12.5	35.21	0.748	0.747	0.009	0.40
CS24-05	mylonitized wm-schist (CB)	CS24-05-69	183.74	3.6	132.33	2.778	0.775	0.013	0.01
CS24-05	mylonitized wm-schist (CB)	CS24-05-70	172.48	4.9	91.57	1.615	0.768	0.014	0.31
CS24-05	mylonitized wm-schist (CB)	CS24-05-71	182.80	4.9	97.95	1.420	0.769	0.014	0.27
CS24-05	mylonitized wm-schist (CB)	CS24-05-72	168.89	7.4	59.46	1.082	0.755	0.013	0.29
CS24-05	mylonitized wm-schist (CB)	CS24-05-73	181.53	7.2	65.41	1.191	0.753	0.011	0.04
CS24-05	mylonitized wm-schist (CB)	CS24-05-74	188.37	6.2	81.47	1.568	0.762	0.020	0.34
CS24-05	mylonitized wm-schist (CB)	CS24-05-75	173.57	4.9	92.35	2.415	0.747	0.016	0.42
CS24-05	mylonitized wm-schist (CB)	CS24-05-76	183.35	6.6	72.65	1.912	0.763	0.012	0.25
CS24-05	mylonitized wm-schist (CB)	CS24-05-77	178.99	7.2	64.77	1.296	0.753	0.012	0.26
CS24-05	mylonitized wm-schist (CB)	CS24-05-78	183.33	5.0	96.98	2.322	0.761	0.018	0.25
CS24-05	mylonitized wm-schist (CB)	CS24-05-79	177.65	5.6	82.52	2.356	0.750	0.016	0.51
CS24-05	mylonitized wm-schist (CB)	CS24-05-80	171.81	4.6	98.86	3.977	0.754	0.019	0.24
CS24-05	mylonitized wm-schist (CB)	CS24-05-81	191.91	4.7	106.32	2.663	0.756	0.018	0.54
CS24-05	mylonitized wm-schist (CB)	CS24-05-82	202.51	3.1	170.41	5.206	0.792	0.023	0.66
CS24-05	mylonitized wm-schist (CB)	CS24-05-83	193.07	6.4	78.92	1.684	0.755	0.013	0.14
CS24-05	mylonitized wm-schist (CB)	CS24-05-84	199.98	5.5	95.40	3.101	0.768	0.013	0.37
CS24-05	mylonitized wm-schist (CB)	CS24-05-85	196.73	6.6	77.27	1.283	0.760	0.015	0.55
CS24-05	mylonitized wm-schist (CB)	CS24-05-86	194.17	4.9	104.30	4.021	0.763	0.015	0.35
CS24-05	mylonitized wm-schist (CB)	CS24-05-87*	199.73	12.9	40.76	1.557	0.745	0.012	0.15
CS24-05	mylonitized wm-schist (CB)	CS24-05-88	183.54	6.1	78.44	2.192	0.749	0.013	0.53
CS24-05	mylonitized wm-schist (CB)	CS24-05-89	307.78	5.0	165.08	10.559	0.767	0.016	0.02
CS24-05	mylonitized wm-schist (CB)	CS24-05-90	187.95	6.9	70.85	1.223	0.767	0.011	0.14

Table S3.1 Analytical results for in situ ⁸⁷Rb/⁸⁶Sr geochronology from the the white mica within CB and CBU samples

Sample Number	Rock Name	Analysis	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
CS24-05	mylonitized wm-schist (CB)	CS24-05-91	174.23	9.0	50.23	0.704	0.757	0.012	0.49
CS24-05	mylonitized wm-schist (CB)	CS24-05-92	192.24	4.0	126.91	3.479	0.779	0.013	0.13
CS24-05	mylonitized wm-schist (CB)	CS24-05-93	189.53	4.1	118.91	1.675	0.775	0.017	0.45
CS24-05	mylonitized wm-schist (CB)	CS24-05-94	192.41	8.1	61.26	1.109	0.761	0.009	0.40
CS24-05	mylonitized wm-schist (CB)	CS24-05-95	186.26	5.0	96.34	2.444	0.762	0.015	0.02
CS24-05	mylonitized wm-schist (CB)	CS24-05-96	181.80	6.1	77.96	2.007	0.756	0.014	0.36
CS24-05	mylonitized wm-schist (CB)	CS24-05-97	193.99	7.4	68.64	1.914	0.759	0.011	0.42
CS24-05	mylonitized wm-schist (CB)	CS24-05-98	184.41	7.2	66.75	1.422	0.754	0.014	0.37
CS24-05	mylonitized wm-schist (CB)	CS24-05-99	189.59	6.5	75.66	1.291	0.772	0.014	0.45
CS24-05	mylonitized wm-schist (CB)	CS24-05-100	178.16	7.1	65.10	1.211	0.754	0.011	0.45
CS24-05	mylonitized wm-schist (CB)	CS24-05-101	193.23	6.9	72.76	1.506	0.743	0.013	0.54
CS24-05	mylonitized wm-schist (CB)	CS24-05-102	193.42	3.1	157.16	3.620	0.795	0.021	0.64
CS24-05	mylonitized wm-schist (CB)	CS24-05-103	208.16	2.8	189.83	4.562	0.783	0.022	0.45
CS24-05	mylonitized wm-schist (CB)	CS24-05-104	197.45	3.2	158.58	3.157	0.802	0.018	0.53
CS24-05	mylonitized wm-schist (CB)	CS24-05-105	180.77	8.1	58.20	2.169	0.753	0.013	-0.12
CS24-05	mylonitized wm-schist (CB)	CS24-05-106	193.17	3.3	154.48	4.185	0.776	0.018	0.53
CS24-05	mylonitized wm-schist (CB)	CS24-05-107	179.39	4.2	109.78	2.652	0.769	0.016	0.17
CS24-05	mylonitized wm-schist (CB)	CS24-05-108	186.89	8.0	60.60	1.622	0.757	0.013	0.47
CS24-05	mylonitized wm-schist (CB)	CS24-05-109	189.19	4.5	109.57	2.653	0.785	0.017	0.34
CS24-05	mylonitized wm-schist (CB)	CS24-05-110	189.86	6.0	82.17	1.986	0.761	0.013	0.02
CS24-05	mylonitized wm-schist (CB)	CS24-05-111	194.81	3.7	136.58	4.030	0.774	0.019	0.32
CS24-05	mylonitized wm-schist (CB)	CS24-05-112	195.30	8.1	62.01	1.357	0.769	0.011	0.46
CS24-05	mylonitized wm-schist (CB)	CS24-05-113	176.31	6.9	66.40	1.349	0.755	0.011	0.09
CS24-05	mylonitized wm-schist (CB)	CS24-05-114	180.62	7.3	64.01	1.163	0.759	0.013	0.46
CS24-05	mylonitized wm-schist (CB)	CS24-05-115	184.67	6.9	69.61	1.941	0.756	0.014	0.38
CS24-05	mylonitized wm-schist (CB)	CS24-05-116	185.80	6.4	75.51	1.899	0.760	0.015	0.12
CS24-05	mylonitized wm-schist (CB)	CS24-05-117	181.44	5.4	87.90	2.006	0.778	0.017	0.41
CS24-05	mylonitized wm-schist (CB)	CS24-05-118	203.01	4.6	114.06	3.230	0.767	0.017	0.13
CS24-10	cal wm-schist (CBU)	CS24-10-1	143.57	2.4	156.92	4.158	0.797	0.027	0.41
CS24-10	cal wm-schist (CBU)	CS24-10-2	105.28	2.3	116.84	3.348	0.753	0.027	0.27
CS24-10	cal wm-schist (CBU)	CS24-10-3	140.77	2.3	157.18	4.496	0.755	0.023	0.32
CS24-10	cal wm-schist (CBU)	CS24-10-4	151.42	2.3	174.89	4.338	0.787	0.026	0.61
CS24-10	cal wm-schist (CBU)	CS24-10-5	154.28	1.9	206.84	4.669	0.805	0.030	0.68
CS24-10	cal wm-schist (CBU)	CS24-10-6	149.18	3.1	122.95	2.951	0.756	0.016	0.58
CS24-10	cal wm-schist (CBU)	CS24-10-7	148.12	2.3	165.50	3.697	0.799	0.020	0.50
CS24-10	cal wm-schist (CBU)	CS24-10-8	157.75	1.6	257.45	7.796	0.836	0.033	0.63
CS24-10	cal wm-schist (CBU)	CS24-10-9	151.42	1.7	230.21	7.479	0.812	0.032	0.63
CS24-10	cal wm-schist (CBU)	CS24-10-10	154.37	2.4	168.60	3.815	0.794	0.018	0.43
CS24-10	cal wm-schist (CBU)	CS24-10-11	147.50	4.0	95.25	2.248	0.744	0.020	0.49
CS24-10	cal wm-schist (CBU)	CS24-10-12	148.38	1.7	232.43	8.739	0.822	0.024	0.54
CS24-10	cal wm-schist (CBU)	CS24-10-13	148.77	4.6	84.52	1.933	0.730	0.016	0.30
CS24-10	cal wm-schist (CBU)	CS24-10-14	160.41	1.7	238.42	7.444	0.796	0.022	0.42
CS24-10	cal wm-schist (CBU)	CS24-10-15	157.35	2.4	169.96	5.538	0.777	0.021	0.37
CS24-10	cal wm-schist (CBU)	CS24-10-16	160.19	1.8	230.17	6.715	0.808	0.028	0.47
CS24-10	cal wm-schist (CBU)	CS24-10-17	133.82	4.3	88.06	8.195	0.744	0.017	0.15
CS24-10	cal wm-schist (CBU)	CS24-10-18	166.20	1.6	271.57	11.884	0.885	0.034	0.69
CS24-10	cal wm-schist (CBU)	CS24-10-19	162.13	1.8	228.50	6.925	0.799	0.020	0.55
CS24-10	cal wm-schist (CBU)	CS24-10-20	159.22	1.9	220.36	6.141	0.791	0.023	0.45
CS24-10	cal wm-schist (CBU)	CS24-10-21	148.76	1.9	204.70	6.924	0.778	0.026	0.39
CS24-10	cal wm-schist (CBU)	CS24-10-22	155.65	1.9	211.08	6.759	0.808	0.027	0.63
CS24-10	cal wm-schist (CBU)	CS24-10-23	162.21	1.9	226.43	5.922	0.805	0.028	0.50
CS24-10	cal wm-schist (CBU)	CS24-10-24	167.48	0.9	462.46	18.028	0.969	0.039	0.55
CS24-10	cal wm-schist (CBU)	CS24-10-25	164.04	1.3	319.09	10.791	0.868	0.031	0.61
CS24-10	cal wm-schist (CBU)	CS24-10-26	164.79	2.4	178.51	5.735	0.774	0.023	0.48
CS24-10	cal wm-schist (CBU)	CS24-10-27	166.50	1.6	271.30	8.690	0.842	0.026	0.51
CS24-10	cal wm-schist (CBU)	CS24-10-28	162.25	3.0	141.44	2.689	0.754	0.019	0.64
CS24-10	cal wm-schist (CBU)	CS24-10-29	161.10	1.5	279.69	9.935	0.826	0.027	0.36
CS24-10	cal wm-schist (CBU)	CS24-10-30	165.59	1.3	327.81	10.839	0.860	0.029	0.48
CS24-10	cal wm-schist (CBU)	CS24-10-31	150.33	2.7	146.16	3.343	0.743	0.019	0.20
CS24-10	cal wm-schist (CBU)	CS24-10-32	145.61	2.4	154.35	3.333	0.785	0.024	0.52
CS24-10	cal wm-schist (CBU)	CS24-10-33	152.74	2.4	165.89	5.075	0.767	0.023	0.31
CS24-10	cal wm-schist (CBU)	CS24-10-34	165.03	1.4	313.93	9.625	0.850	0.031	0.35
CS24-10	cal wm-schist (CBU)	CS24-10-35	157.67	2.7	150.95	3.155	0.762	0.020	0.43
CS24-10	cal wm-schist (CBU)	CS24-10-36	147.72	3.8	101.42	2.224	0.742	0.018	0.33
CS24-10	cal wm-schist (CBU)	CS24-10-37	150.39	3.2	123.18	3.864	0.750	0.018	0.07
CS24-10	cal wm-schist (CBU)	CS24-10-38	164.04	1.3	323.50	9.588	0.907	0.030	0.57
CS24-10	cal wm-schist (CBU)	CS24-10-39	148.45	2.1	187.08	4.408	0.793	0.024	0.61
CS24-10	cal wm-schist (CBU)	CS24-10-40	165.08	1.8	234.25	7.257	0.806	0.024	0.55
CS24-10	cal wm-schist (CBU)	CS24-10-41	160.35	1.1	390.88	11.892	0.902	0.046	0.67
CS24-10	cal wm-schist (CBU)	CS24-10-42	144.86	2.9	129.46	3.337	0.748	0.021	0.57
CS24-10	cal wm-schist (CBU)	CS24-10-43	133.59	3.3	102.95	2.273	0.747	0.016	0.44
CS24-10	cal wm-schist (CBU)	CS24-10-44	172.61	1.0	441.62	16.110	0.909	0.041	0.64
CS24-10	cal wm-schist (CBU)	CS24-10-45	150.64	3.0	130.58	3.542	0.765	0.021	0.27
CS24-10	cal wm-schist (CBU)	CS24-10-46	146.80	2.3	165.77	4.576	0.787	0.025	0.61
CS24-10	cal wm-schist (CBU)	CS24-10-47	52.06	1.3	104.48	3.968	0.756	0.028	0.53
CS24-10	cal wm-schist (CBU)	CS24-10-48	156.37	1.6	251.89	5.991	0.827	0.027	0.72
CS24-10	cal wm-schist (CBU)	CS24-10-49	153.57	2.4	168.85	3.904	0.769	0.022	0.52
CS24-10	cal wm-schist (CBU)	CS24-10-50	136.12	3.7	95.39	2.888	0.721	0.015	0.29
CS24-10	cal wm-schist (CBU)	CS24-10-51	118.45	2.9	105.60	3.163	0.737	0.020	0.22
CS24-10	cal wm-schist (CBU)	CS24-10-52	139.05	1.8	205.35	5.379	0.784	0.027	0.63
CS24-10	cal wm-schist (CBU)	CS24-10-53	166.46	1.6	276.64	9.602	0.802	0.025	0.55
CS24-10	cal wm-schist (CBU)	CS24-10-54	138.03	2.5	142.47	4.680	0.759	0.024	0.60
CS24-10	cal wm-schist (CBU)	CS24-10-55	115.48	3.0	99.86	3.085	0.744	0.016	0.35
CS24-10	cal wm-schist (CBU)	CS24-10-56	164.24	1.9	231.30	10.934	0.792	0.028	0.43
CS24-10	cal wm-schist (CBU)	CS24-10-57	159.36	3.8	108.93	2.283	0.743	0.019	0.66
CS24-10	cal wm-schist (CBU)	CS24-10-58	169.11	2.3	191.63	5.507	0.803	0.023	0.58
CS24-10	cal wm-schist (CBU)	CS24-10-59	161.89	1.2	352.80	11.611	0.893	0.036	0.50
CS24-10	cal wm-schist (CBU)	CS24-10-60	160.00	1.3	310.47	9.018	0.854	0.035	0.55
CS24-10	cal wm-schist (CBU)	CS24-10-61	162.84	2.2	192.98	4.762	0.806	0.019	0.65
CS24-10	cal wm-schist (CBU)	CS24-10-62	156.07	2.3	178.21	3.782	0.782	0.026	0.55

Table S3.1 Analytical results for in situ ⁸⁷Rb/⁸⁶Sr geochronology from the the white mica within CB and CBU samples

Sample Number	Rock Name	Analysis	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
CS24-10	cal wm-schist (CBU)	CS24-10-63	145.54	6.6	57.40	1.249	0.729	0.012	0.39
CS24-10	cal wm-schist (CBU)	CS24-10-64*	54.09	42.5	3.43	0.192	0.704	0.010	-0.10
CS24-10	cal wm-schist (CBU)	CS24-10-65*	22.51	59.4	0.99	0.021	0.713	0.008	0.32
CS24-10	cal wm-schist (CBU)	CS24-10-66	159.54	1.2	347.22	10.132	0.889	0.040	0.62
CS24-10	cal wm-schist (CBU)	CS24-10-67	136.81	2.1	172.09	4.412	0.761	0.026	0.50
CS24-10	cal wm-schist (CBU)	CS24-10-68	165.03	1.5	286.53	9.511	0.862	0.028	0.64
CS24-10	cal wm-schist (CBU)	CS24-10-69	162.73	1.1	390.67	14.418	0.892	0.035	0.57
CS24-10	cal wm-schist (CBU)	CS24-10-70	161.53	1.9	226.43	4.900	0.797	0.023	0.65
CS24-10	cal wm-schist (CBU)	CS24-10-71	167.10	1.4	316.72	18.412	0.840	0.033	0.35
CS24-10	cal wm-schist (CBU)	CS24-10-72	161.60	3.6	115.18	3.644	0.748	0.021	0.41
CS24-10	cal wm-schist (CBU)	CS24-10-73	181.28	0.8	599.37	19.458	1.036	0.046	0.62
CS24-10	cal wm-schist (CBU)	CS24-10-74	149.67	2.3	172.00	5.065	0.778	0.026	0.46
CS24-10	cal wm-schist (CBU)	CS24-10-75	142.88	2.1	175.35	6.313	0.776	0.024	0.44
CS24-10	cal wm-schist (CBU)	CS24-10-76	160.97	1.4	294.60	9.990	0.854	0.026	0.48
CS24-10	cal wm-schist (CBU)	CS24-10-77	163.97	2.5	172.05	6.550	0.792	0.026	0.44
CS24-10	cal wm-schist (CBU)	CS24-10-78	132.91	3.6	96.93	2.125	0.748	0.015	0.46
CS24-10	cal wm-schist (CBU)	CS24-10-79	144.69	4.6	81.42	2.285	0.736	0.015	0.33
CS24-10	cal wm-schist (CBU)	CS24-10-80	165.66	1.6	276.46	8.646	0.806	0.027	0.50
CS24-10	cal wm-schist (CBU)	CS24-10-81	116.17	4.4	68.53	1.269	0.735	0.016	0.29
CS24-10	cal wm-schist (CBU)	CS24-10-82	148.24	2.5	154.39	3.975	0.748	0.023	0.54
CS24-10	cal wm-schist (CBU)	CS24-10-83	159.46	3.7	112.11	4.438	0.740	0.016	0.03
CS24-10	cal wm-schist (CBU)	CS24-10-84	143.74	3.0	124.00	2.423	0.744	0.019	0.57
CS24-10	cal wm-schist (CBU)	CS24-10-85*	104.89	13.7	32.75	8.276	0.711	0.020	0.20
CS24-10	cal wm-schist (CBU)	CS24-10-86	157.56	5.8	71.40	1.192	0.736	0.014	0.28
CS24-10	cal wm-schist (CBU)	CS24-10-87	168.35	1.9	230.25	7.470	0.771	0.023	0.68
CS24-10	cal wm-schist (CBU)	CS24-10-88	169.94	1.2	369.19	10.118	0.873	0.033	0.52
CS24-10	cal wm-schist (CBU)	CS24-10-89	156.11	4.6	88.87	1.515	0.735	0.012	0.51
CS24-10	cal wm-schist (CBU)	CS24-10-90	166.78	3.5	126.17	1.788	0.764	0.020	0.42
CS24-10	cal wm-schist (CBU)	CS24-10-91	168.88	2.5	179.16	3.961	0.785	0.024	0.52
CS24-10	cal wm-schist (CBU)	CS24-10-92*	127.12	14.9	19.72	2.706	0.693	0.020	0.66
CS24-10	cal wm-schist (CBU)	CS24-10-93	151.56	3.4	118.38	4.100	0.734	0.018	0.29
CS24-10	cal wm-schist (CBU)	CS24-10-94	151.54	4.4	90.98	3.373	0.720	0.013	0.21
CS24-10	cal wm-schist (CBU)	CS24-10-95	164.87	1.9	226.63	6.445	0.830	0.027	0.42
CS24-10	cal wm-schist (CBU)	CS24-10-96	147.73	6.3	64.90	4.027	0.738	0.016	0.37
CS24-10	cal wm-schist (CBU)	CS24-10-97	128.04	2.6	131.59	5.755	0.888	0.182	0.19
CS24-10	cal wm-schist (CBU)	CS24-10-98	156.11	2.9	143.60	6.907	0.779	0.023	0.57
CS24-10	cal wm-schist (CBU)	CS24-10-99	164.76	2.2	199.04	10.818	0.784	0.028	0.23
CS24-10	cal wm-schist (CBU)	CS24-10-100	1.47	4.3	0.94	0.035	0.712	0.016	0.16
CS24-10	cal wm-schist (CBU)	CS24-10-101	0.08	4.4	0.08	0.009	0.698	0.015	0.01
CS24-10	cal wm-schist (CBU)	CS24-10-102	160.17	0.9	466.60	16.605	0.984	0.047	0.62
CS24-10	cal wm-schist (CBU)	CS24-10-103	1.36	1.0	3.62	0.672	0.706	0.031	0.05
CS24-10	cal wm-schist (CBU)	CS24-10-104	169.02	1.5	311.47	18.964	0.872	0.032	0.69
CS24-10	cal wm-schist (CBU)	CS24-10-105	163.86	1.7	253.84	9.603	0.812	0.029	0.43
CS24-10	cal wm-schist (CBU)	CS24-10-106	167.09	1.5	284.50	7.760	0.820	0.033	0.65
CS24-10	cal wm-schist (CBU)	CS24-10-107	165.45	2.2	202.28	8.820	0.808	0.028	0.41
CS24-10	cal wm-schist (CBU)	CS24-10-108	173.04	3.8	129.51	10.413	0.758	0.017	0.24
CS24-10	cal wm-schist (CBU)	CS24-10-109	153.77	5.1	80.69	3.144	0.740	0.017	0.43
CS24-10	cal wm-schist (CBU)	CS24-10-110	174.14	1.6	285.37	7.765	0.849	0.033	0.67
CS24-10	cal wm-schist (CBU)	CS24-10-111	164.69	2.6	171.45	8.225	0.773	0.027	0.39
CS24-10	cal wm-schist (CBU)	CS24-10-112	142.92	1.9	197.14	5.899	0.789	0.024	0.60
CS24-10	cal wm-schist (CBU)	CS24-10-113	156.89	2.9	140.67	2.529	0.744	0.021	0.55
CS24-10	cal wm-schist (CBU)	CS24-10-114	156.59	2.6	154.76	3.553	0.754	0.020	0.53
CS24-10	cal wm-schist (CBU)	CS24-10-115	109.47	3.7	77.14	1.507	0.729	0.015	0.37
CS24-10	cal wm-schist (CBU)	CS24-10-116	156.92	2.5	169.37	9.790	0.777	0.018	0.43
CS24-10	cal wm-schist (CBU)	CS24-10-117	168.08	1.6	276.28	5.947	0.838	0.026	0.45
CS24-10	cal wm-schist (CBU)	CS24-10-118	181.66	1.2	405.51	16.153	0.923	0.043	0.63
CS24-21	orthogneiss (CB)	CS24-21-1	171.78	1.0	465.02	20.584	0.828	0.039	0.62
CS24-21	orthogneiss (CB)	CS24-21-2	160.97	1.0	433.57	18.721	0.856	0.037	0.50
CS24-21	orthogneiss (CB)	CS24-21-3	160.63	0.7	613.22	24.336	0.957	0.050	0.62
CS24-21	orthogneiss (CB)	CS24-21-4	170.50	9.8	45.47	1.954	0.730	0.013	0.27
CS24-21	orthogneiss (CB)	CS24-21-5	171.40	6.5	71.43	5.043	0.734	0.015	0.31
CS24-21	orthogneiss (CB)	CS24-21-6	152.21	0.7	593.14	29.467	0.852	0.050	0.53
CS24-21	orthogneiss (CB)	CS24-21-7	183.10	0.7	733.78	36.871	0.911	0.050	0.69
CS24-21	orthogneiss (CB)	CS24-21-8*	0.38	0.0	44.79	13.416	1.118	0.355	0.45
CS24-21	orthogneiss (CB)	CS24-21-9	32.84	0.4	301.73	41.494	0.772	0.069	0.48
CS24-21	orthogneiss (CB)	CS24-21-10	173.60	0.6	786.62	36.950	0.924	0.054	0.39
CS24-21	orthogneiss (CB)	CS24-21-11	162.14	3.7	140.80	24.474	0.749	0.023	0.06
CS24-21	orthogneiss (CB)	CS24-21-12	177.28	10.8	44.19	2.734	0.724	0.013	0.23
CS24-21	orthogneiss (CB)	CS24-21-13	160.66	0.2	2129.27	110.287	1.319	0.099	0.50
CS24-21	orthogneiss (CB)	CS24-21-14	167.19	1.0	420.99	20.231	0.847	0.045	0.59
CS24-21	orthogneiss (CB)	CS24-21-15	144.08	0.4	989.67	73.208	0.935	0.059	0.39
CS24-21	orthogneiss (CB)	CS24-21-16	154.30	0.6	712.44	40.257	0.912	0.041	0.67
CS24-21	orthogneiss (CB)	CS24-21-17	132.85	14.2	23.61	1.275	0.719	0.015	0.00
CS24-21	orthogneiss (CB)	CS24-21-18	142.61	12.6	29.41	0.704	0.721	0.014	0.33
CS24-21	orthogneiss (CB)	CS24-21-19	144.47	0.2	1721.72	165.386	1.299	0.116	0.66
CS24-21	orthogneiss (CB)	CS24-21-20	164.10	0.3	1771.20	111.551	1.292	0.086	0.72
CS24-21	orthogneiss (CB)	CS24-21-21	156.83	0.8	484.66	16.444	0.860	0.036	0.60
CS24-21	orthogneiss (CB)	CS24-21-22	162.24	64.6	6.56	0.217	0.718	0.010	0.28
CS24-21	orthogneiss (CB)	CS24-21-23	162.33	1.0	413.74	22.367	0.861	0.046	0.61
CS24-21	orthogneiss (CB)	CS24-21-24	151.90	0.4	1105.59	103.953	0.986	0.075	0.54
CS24-21	orthogneiss (CB)	CS24-21-25	160.37	1.2	348.30	10.890	0.802	0.036	0.55
CS24-21	orthogneiss (CB)	CS24-21-26	160.60	1.3	310.16	14.741	0.833	0.037	0.46
CS24-21	orthogneiss (CB)	CS24-21-27	158.35	0.9	449.59	21.196	0.857	0.042	0.66
CS24-21	orthogneiss (CB)	CS24-21-28	171.81	1.7	261.92	8.183	0.802	0.030	0.61
CS24-21	orthogneiss (CB)	CS24-21-29	166.51	1.5	291.74	14.412	0.801	0.025	0.55
CS24-21	orthogneiss (CB)	CS24-21-30*	0.01	0.5	0.62	0.111	0.690	0.054	0.19
CS24-21	orthogneiss (CB)	CS24-21-31	184.52	4.0	121.63	3.672	0.750	0.020	0.40
CS24-21	orthogneiss (CB)	CS24-21-32	183.02	0.9	516.52	24.126	0.870	0.039	0.52
CS24-21	orthogneiss (CB)	CS24-21-33	171.09	34.3	12.98	0.429	0.716	0.009	0.24
CS24-21	orthogneiss (CB)	CS24-21-34	157.60	0.3	1318.15	76.499	1.122	0.086	0.70

Table S3.1 Analytical results for in situ ⁸⁷Rb/⁸⁶Sr geochronology from the the white mica within CB and CBU samples

Sample Number	Rock Name	Analysis	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
CS24-21	orthogneiss (CB)	CS24-21-35	177.27	5.8	83.85	6.249	0.730	0.024	0.04
CS24-21	orthogneiss (CB)	CS24-21-36	174.95	0.7	682.05	38.228	0.937	0.048	0.70
CS24-21	orthogneiss (CB)	CS24-21-37	188.21	0.8	688.03	74.938	0.916	0.055	0.05
CS24-21	orthogneiss (CB)	CS24-21-38	168.73	0.4	1156.02	108.601	0.974	0.058	0.61
CS24-21	orthogneiss (CB)	CS24-21-39	169.09	0.7	678.66	29.261	0.927	0.064	0.49
CS24-21	orthogneiss (CB)	CS24-21-40	155.09	0.9	443.47	16.002	0.795	0.036	0.51
CS24-21	orthogneiss (CB)	CS24-21-41	173.42	0.7	629.04	27.852	0.875	0.048	0.63
CS24-21	orthogneiss (CB)	CS24-21-42	162.69	1.1	410.04	20.994	0.837	0.037	0.59
CS24-21	orthogneiss (CB)	CS24-21-43	174.98	1.4	321.71	13.023	0.781	0.029	0.52
CS24-21	orthogneiss (CB)	CS24-21-44	168.17	3.4	130.76	4.701	0.753	0.018	0.35
CS24-21	orthogneiss (CB)	CS24-21-45	155.44	2.7	149.35	5.632	0.751	0.020	0.10
CS24-21	orthogneiss (CB)	CS24-21-46	163.39	1.1	365.63	13.191	0.827	0.043	0.60
CS24-21	orthogneiss (CB)	CS24-21-47	155.16	32.1	12.57	0.252	0.716	0.010	0.19
CS24-21	orthogneiss (CB)	CS24-21-48	158.21	1.2	337.04	10.579	0.822	0.037	0.69
CS24-21	orthogneiss (CB)	CS24-21-49	162.53	1.1	386.88	11.385	0.827	0.038	0.63
CS24-21	orthogneiss (CB)	CS24-21-50	183.66	0.6	794.76	29.863	0.951	0.064	0.07
CS24-21	orthogneiss (CB)	CS24-21-51	186.31	0.5	1015.18	44.260	1.045	0.059	0.65
CS24-21	orthogneiss (CB)	CS24-21-52	167.93	0.6	738.97	26.600	0.943	0.054	0.35
CS24-21	orthogneiss (CB)	CS24-21-53	181.93	0.6	748.77	33.699	0.912	0.066	0.69
CS24-21	orthogneiss (CB)	CS24-21-54	163.80	0.8	566.92	20.843	0.883	0.033	0.61
CS24-21	orthogneiss (CB)	CS24-21-55	163.92	0.4	1001.09	64.072	0.987	0.075	0.77
CS24-21	orthogneiss (CB)	CS24-21-56	173.95	1.0	455.21	20.138	0.811	0.043	-0.05
CS24-21	orthogneiss (CB)	CS24-21-57	161.58	1.1	383.46	11.299	0.823	0.040	0.72
CS24-21	orthogneiss (CB)	CS24-21-58	162.29	0.2	2676.94	185.944	1.460	0.124	0.78
CS24-21	orthogneiss (CB)	CS24-21-59	189.96	1.4	353.78	11.711	0.800	0.037	0.82
CS24-21	orthogneiss (CB)	CS24-21-60	179.47	0.5	872.22	37.529	0.975	0.062	0.80
CS24-21	orthogneiss (CB)	CS24-21-61	200.87	0.7	773.33	32.570	0.958	0.050	0.66
CS24-21	orthogneiss (CB)	CS24-21-62	168.42	0.3	1675.44	93.703	1.201	0.073	0.74
CS24-21	orthogneiss (CB)	CS24-21-63	179.39	1.1	429.38	12.392	0.807	0.036	0.53
CS24-21	orthogneiss (CB)	CS24-21-64	146.24	0.2	2239.94	149.313	1.378	0.117	0.89
CS24-21	orthogneiss (CB)	CS24-21-65	159.19	0.8	547.43	18.040	0.929	0.047	0.58
CS24-21	orthogneiss (CB)	CS24-21-66	191.62	0.4	1151.87	55.853	1.028	0.066	0.68
CS24-21	orthogneiss (CB)	CS24-21-67	154.48	0.8	521.96	18.729	0.867	0.042	0.46
CS24-21	orthogneiss (CB)	CS24-21-68	191.15	0.7	677.07	22.125	0.855	0.045	0.17
CS24-21	orthogneiss (CB)	CS24-21-69	184.04	0.6	787.26	40.951	0.923	0.052	0.75
CS24-21	orthogneiss (CB)	CS24-21-70	188.04	0.5	1056.77	76.326	0.983	0.051	0.53
CS24-21	orthogneiss (CB)	CS24-21-71	189.24	0.2	2493.89	311.015	1.341	0.117	0.76
CS24-21	orthogneiss (CB)	CS24-21-72	167.19	0.1	6760.38	678.429	2.590	0.295	0.79
CS24-21	orthogneiss (CB)	CS24-21-73	77.59	0.5	419.43	29.524	0.793	0.042	0.46
CS24-21	orthogneiss (CB)	CS24-21-74	186.96	0.6	818.99	38.098	0.962	0.051	0.63
CS24-21	orthogneiss (CB)	CS24-21-75	184.30	0.5	945.98	44.899	0.953	0.043	0.73
CS24-21	orthogneiss (CB)	CS24-21-76	181.84	0.9	510.32	20.367	0.840	0.047	0.51
CS24-21	orthogneiss (CB)	CS24-21-77	183.10	0.7	688.30	31.965	0.903	0.047	0.50
CS24-21	orthogneiss (CB)	CS24-21-78	176.61	0.4	1084.24	66.085	0.993	0.063	0.42
CS24-21	orthogneiss (CB)	CS24-21-79	161.06	0.5	866.18	64.058	0.997	0.060	0.45
CS24-21	orthogneiss (CB)	CS24-21-80	151.88	0.8	477.34	21.387	0.874	0.049	0.42
CS24-21	orthogneiss (CB)	CS24-21-81	175.01	0.6	757.96	33.903	0.914	0.055	0.76
CS24-21	orthogneiss (CB)	CS24-21-82	174.13	0.8	593.18	24.278	0.911	0.028	0.37
CS24-21	orthogneiss (CB)	CS24-21-83	179.38	1.3	366.42	22.756	0.802	0.027	0.38
CS24-21	orthogneiss (CB)	CS24-21-84	186.51	0.9	538.48	19.530	0.867	0.037	0.39
CS24-21	orthogneiss (CB)	CS24-21-85	174.41	0.8	554.41	22.247	0.842	0.034	0.63
CS24-21	orthogneiss (CB)	CS24-21-86	144.71	0.3	1111.55	68.063	1.078	0.086	0.65
CS24-21	orthogneiss (CB)	CS24-21-87	180.29	0.9	546.87	24.806	0.890	0.033	0.40
CS24-21	orthogneiss (CB)	CS24-21-88*	0.86	0.2	12.76	3.149	1.017	0.276	0.34
CS24-21	orthogneiss (CB)	CS24-21-89*	-0.01	0.0	12.22	1.934	0.432	0.189	0.67
CS24-21	orthogneiss (CB)	CS24-21-90	162.05	0.3	2055.87	342.950	1.325	0.118	0.75
CS24-21	orthogneiss (CB)	CS24-21-91	168.00	1.2	375.31	20.747	0.854	0.032	0.37
CS24-21	orthogneiss (CB)	CS24-21-92	187.22	0.9	573.27	18.869	0.907	0.043	0.65
CS24-21	orthogneiss (CB)	CS24-21-93	168.60	0.6	678.48	26.294	0.873	0.042	0.68
CS24-21	orthogneiss (CB)	CS24-21-94	173.36	0.1	4176.06	470.036	1.854	0.213	0.84
CS24-21	orthogneiss (CB)	CS24-21-95	168.31	0.1	6307.39	987.553	2.365	0.357	0.92
CS24-21	orthogneiss (CB)	CS24-21-96	178.27	1.2	413.22	21.498	0.840	0.042	0.54
CS24-21	orthogneiss (CB)	CS24-21-97	182.67	0.9	546.74	21.274	0.889	0.048	0.76
CS24-21	orthogneiss (CB)	CS24-21-98	191.39	0.8	668.20	42.013	0.892	0.043	0.68
CS24-21	orthogneiss (CB)	CS24-21-99	171.68	0.7	667.76	24.870	0.891	0.047	0.31
CS24-21	orthogneiss (CB)	CS24-21-100	167.52	0.6	800.58	30.791	0.952	0.058	0.64
CS24-21	orthogneiss (CB)	CS24-21-101	176.35	0.3	1437.54	73.449	1.151	0.067	0.46
CS24-21	orthogneiss (CB)	CS24-21-102	177.69	0.6	763.60	40.499	0.961	0.054	0.66
CS24-21	orthogneiss (CB)	CS24-21-103	182.70	0.5	952.78	43.626	0.980	0.064	0.69
CS24-21	orthogneiss (CB)	CS24-21-104	185.53	0.3	1516.97	70.897	1.160	0.084	0.64
CS24-21	orthogneiss (CB)	CS24-21-105	199.03	0.9	612.35	28.179	0.872	0.041	0.48
CS24-21	orthogneiss (CB)	CS24-21-106	163.02	0.6	697.79	28.838	0.954	0.055	0.67
CS24-21	orthogneiss (CB)	CS24-21-107	170.04	1.9	240.04	8.146	0.778	0.034	0.44
CS24-21	orthogneiss (CB)	CS24-21-108	173.42	0.5	973.58	44.102	0.975	0.058	0.65
CS24-21	orthogneiss (CB)	CS24-21-109	162.00	0.4	1201.37	70.974	1.086	0.075	0.66
CS24-21	orthogneiss (CB)	CS24-21-110	160.64	0.9	500.40	28.109	0.810	0.047	0.38
CS24-21	orthogneiss (CB)	CS24-21-111	166.84	0.2	1862.51	143.213	1.224	0.094	0.69
CS24-21	orthogneiss (CB)	CS24-21-112	183.70	0.8	572.50	20.348	0.890	0.045	0.31
CS24-21	orthogneiss (CB)	CS24-21-113	165.43	0.6	772.83	32.882	0.955	0.052	0.67
CS24-21	orthogneiss (CB)	CS24-21-114	178.77	0.8	579.14	26.028	0.846	0.048	0.44
CS24-21	orthogneiss (CB)	CS24-21-115	147.39	0.7	618.94	55.470	1.259	0.407	0.08
CS24-21	orthogneiss (CB)	CS24-21-116	190.54	5.0	100.67	3.360	0.760	0.020	0.29
CS24-21	orthogneiss (CB)	CS24-21-117	159.69	0.3	1315.95	70.033	1.160	0.067	0.31
CS24-21	orthogneiss (CB)	CS24-21-118	0.21	0.2	2.93	0.512	0.792	0.078	0.15
CS24-21	orthogneiss (CB)	CS24-21-119	0.02	0.1	3.73	0.575	0.972	0.264	0.48
CS24-12	orthogneiss (CB)	CS24-12-1	171.56	7.2	3242.01	116.303	1.761	0.097	0.72
CS24-12	orthogneiss (CB)	CS24-12-2	238.47	8.6	1134.95	28.459	1.114	0.038	0.65
CS24-12	orthogneiss (CB)	CS24-12-3	176.90	4.0	2127.99	115.992	1.524	0.097	0.77
CS24-12	orthogneiss (CB)	CS24-12-4	281.56	9.1	1063.57	38.707	1.156	0.042	0.59
CS24-12	orthogneiss (CB)	CS24-12-5	199.34	2.8	1675.53	65.414	1.331	0.058	0.65

Table S3.1 Analytical results for in situ ⁸⁷Rb/⁸⁶Sr geochronology from the the white mica within CB and CBU samples

Sample Number	Rock Name	Analysis	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
CS24-12	orthogneiss (CB)	CS24-12-6	264.12	6.6	3862.56	203.420	2.014	0.151	0.74
CS24-12	orthogneiss (CB)	CS24-12-7	153.88	4.2	1935.09	90.368	1.383	0.075	0.83
CS24-12	orthogneiss (CB)	CS24-12-8	287.44	9.0	1109.32	31.218	1.174	0.056	0.65
CS24-12	orthogneiss (CB)	CS24-12-9	215.77	5.3	1297.48	48.915	1.210	0.043	0.58
CS24-12	orthogneiss (CB)	CS24-12-10	169.22	3.1	1445.73	45.592	1.235	0.053	0.60
CS24-12	orthogneiss (CB)	CS24-12-11	258.99	7.7	2726.62	123.549	1.654	0.102	0.75
CS24-12	orthogneiss (CB)	CS24-12-12	181.67	2.9	1155.42	50.206	1.174	0.045	0.67
CS24-12	orthogneiss (CB)	CS24-12-13	243.12	9.6	757.96	21.440	1.025	0.039	0.61
CS24-12	orthogneiss (CB)	CS24-12-14	172.44	6.0	1357.46	48.832	1.253	0.049	0.55
CS24-12	orthogneiss (CB)	CS24-12-15	269.78	4.9	1997.66	86.233	1.456	0.082	0.80
CS24-12	orthogneiss (CB)	CS24-12-16	202.34	8.2	718.55	53.471	0.988	0.039	0.25
CS24-12	orthogneiss (CB)	CS24-12-17	155.91	6.0	1075.67	41.922	1.144	0.044	0.46
CS24-12	orthogneiss (CB)	CS24-12-18	278.66	3.8	1403.98	46.292	1.336	0.054	0.42
CS24-12	orthogneiss (CB)	CS24-12-19	231.45	7.1	2950.37	172.146	1.832	0.150	0.78
CS24-12	orthogneiss (CB)	CS24-12-20	187.99	2.4	4383.45	263.176	2.057	0.174	0.85
CS24-12	orthogneiss (CB)	CS24-12-21	260.12	6.9	2095.42	260.676	1.532	0.120	0.87
CS24-12	orthogneiss (CB)	CS24-12-22	174.55	4.1	1032.93	49.076	1.143	0.045	0.77
CS24-12	orthogneiss (CB)	CS24-12-23	285.00	9.0	2057.95	83.911	1.501	0.072	0.75
CS24-12	orthogneiss (CB)	CS24-12-24	220.77	5.8	1150.51	40.024	1.164	0.047	0.73
CS24-12	orthogneiss (CB)	CS24-12-25	193.56	3.7	2375.91	283.941	1.574	0.230	0.57
CS24-12	orthogneiss (CB)	CS24-12-26	249.88	8.6	3780.66	217.351	1.940	0.111	0.76
CS24-12	orthogneiss (CB)	CS24-12-27	166.12	6.3	3672.57	213.127	1.925	0.148	0.77
CS24-12	orthogneiss (CB)	CS24-12-28	271.55	3.0	1674.96	69.160	1.360	0.066	0.55
CS24-12	orthogneiss (CB)	CS24-12-29	158.00	7.4	1575.81	67.701	1.356	0.065	0.07
CS24-12	orthogneiss (CB)	CS24-12-30	283.66	4.6	1260.25	50.986	1.196	0.042	0.42
CS24-12	orthogneiss (CB)	CS24-12-31	206.34	9.9	2814.65	208.691	1.852	0.133	0.48
CS24-12	orthogneiss (CB)	CS24-12-32	177.44	5.2	1231.65	64.146	1.263	0.056	0.58
CS24-12	orthogneiss (CB)	CS24-12-33	254.77	3.0	1476.92	70.992	1.311	0.074	0.71
CS24-12	orthogneiss (CB)	CS24-12-34	189.23	8.8	767.82	17.213	1.083	0.033	0.61
CS24-12	orthogneiss (CB)	CS24-12-35	268.34	6.1	5228.13	509.901	2.378	0.206	0.72
CS24-12	orthogneiss (CB)	CS24-12-36	160.77	2.7	3404.91	197.407	1.928	0.134	0.73
CS24-12	orthogneiss (CB)	CS24-12-37	275.00	7.9	841.86	32.514	1.080	0.043	0.53
CS24-12	orthogneiss (CB)	CS24-12-38	211.56	4.8	78.25	3.612	0.869	0.016	0.23
CS24-12	orthogneiss (CB)	CS24-12-39	196.34	9.2	2391.71	101.852	1.575	0.077	0.62
CS24-12	orthogneiss (CB)	CS24-12-40	247.12	5.7	2689.47	126.579	1.708	0.100	0.76
CS24-12	orthogneiss (CB)	CS24-12-41	170.99	3.4	1070.36	39.967	1.176	0.047	0.76
CS24-12	orthogneiss (CB)	CS24-12-42	280.56	8.1	678.82	20.398	2.020	0.063	0.83
CS24-12	orthogneiss (CB)	CS24-12-43	184.44	7.0	1072.83	33.409	1.197	0.054	0.71
CS24-12	orthogneiss (CB)	CS24-12-44	262.78	2.3	796.09	43.345	1.075	0.071	0.46
CS24-12	orthogneiss (CB)	CS24-12-45	151.99	7.1	2963.40	151.157	1.732	0.125	0.82
CS24-12	orthogneiss (CB)	CS24-12-46	273.66	5.0	1255.40	60.382	1.245	0.061	0.44
CS24-12	orthogneiss (CB)	CS24-12-47	205.12	9.7	1808.65	138.481	1.420	0.090	0.42
CS24-12	orthogneiss (CB)	CS24-12-48	179.77	5.0	138.78	9.669	0.894	0.015	0.45
CS24-12	orthogneiss (CB)	CS24-12-49	259.44	3.8	1135.36	53.168	1.174	0.061	0.68
CS24-12	orthogneiss (CB)	CS24-12-50	192.01	8.6	1004.22	29.035	1.159	0.043	0.76
CS24-12	orthogneiss (CB)	CS24-12-51	282.33	6.2	293.06	26.840	0.967	0.034	0.39
CS24-12	orthogneiss (CB)	CS24-12-52	163.77	2.9	146.91	8.007	0.896	0.015	0.13
CS24-12	orthogneiss (CB)	CS24-12-53	270.56	7.4	100.43	2.027	0.890	0.014	0.29
CS24-12	orthogneiss (CB)	CS24-12-54	216.34	4.3	143.83	4.686	0.902	0.017	0.16
CS24-12	orthogneiss (CB)	CS24-12-55	198.77	9.0	104.07	3.049	0.896	0.015	0.42
CS24-12	orthogneiss (CB)	CS24-12-56	244.12	5.8	193.40	6.983	0.908	0.017	0.53
CS24-12	orthogneiss (CB)	CS24-12-57	175.66	3.1	137.11	4.149	0.892	0.016	0.09
CS24-12	orthogneiss (CB)	CS24-12-58	286.01	8.7	177.98	4.011	0.910	0.017	0.51
CS24-12	orthogneiss (CB)	CS24-12-59	222.77	6.6	213.75	6.571	0.900	0.018	0.40
CS24-12	orthogneiss (CB)	CS24-12-60	190.45	2.4	143.72	14.794	0.900	0.015	0.30
CS24-12	orthogneiss (CB)	CS24-12-61	261.78	7.9	150.92	4.135	0.899	0.019	0.26
CS24-12	orthogneiss (CB)	CS24-12-62	167.99	4.8	171.59	5.771	0.900	0.019	0.33
CS24-12	orthogneiss (CB)	CS24-12-63	276.44	9.3	103.02	5.175	0.886	0.013	-0.08
CS24-12	orthogneiss (CB)	CS24-12-64	208.12	5.1	97.47	2.069	0.879	0.014	0.45
CS24-12	orthogneiss (CB)	CS24-12-65	183.77	3.7	62.09	3.496	0.878	0.011	0.19
CS24-12	orthogneiss (CB)	CS24-12-66	257.33	8.0	78.57	2.926	0.864	0.012	-0.07
CS24-16	grt-wm schist (CB)	CS24-16-1*	100.34	2.4	0.12	0.008	0.726	0.006	-0.09
CS24-16	grt-wm schist (CB)	CS24-16-2	214.88	6.9	0.24	0.003	0.726	0.005	-0.01
CS24-16	grt-wm schist (CB)	CS24-16-3	176.44	3.4	0.06	0.001	0.725	0.004	0.03
CS24-16	grt-wm schist (CB)	CS24-16-4	273.22	9.2	21.96	0.569	0.726	0.007	0.17
CS24-16	grt-wm schist (CB)	CS24-16-5	142.78	2.8	0.16	0.007	0.728	0.006	-0.07
CS24-16	grt-wm schist (CB)	CS24-16-6	231.11	7.1	0.68	0.035	0.727	0.005	-0.06
CS24-16	grt-wm schist (CB)	CS24-16-7	164.56	4.6	0.12	0.005	0.731	0.008	0.30
CS24-16	grt-wm schist (CB)	CS24-16-8	258.99	9.0	0.40	0.037	0.724	0.004	0.27
CS24-16	grt-wm schist (CB)	CS24-16-9	195.66	5.7	0.07	0.003	0.730	0.006	0.20
CS24-16	grt-wm schist (CB)	CS24-16-10	153.12	3.1	0.25	0.009	0.730	0.006	-0.06
CS24-16	grt-wm schist (CB)	CS24-16-11	247.44	7.4	23.22	0.582	0.727	0.007	0.19
CS24-16	grt-wm schist (CB)	CS24-16-12	138.99	3.0	0.07	0.001	0.730	0.005	0.25
CS24-16	grt-wm schist (CB)	CS24-16-13	279.56	9.6	0.22	0.008	0.726	0.006	-0.16
CS24-16	grt-wm schist (CB)	CS24-16-14	206.00	6.0	0.06	0.002	0.727	0.005	0.12
CS24-16	grt-wm schist (CB)	CS24-16-15	174.89	4.9	26.89	0.857	0.734	0.007	0.22
CS24-16	grt-wm schist (CB)	CS24-16-16	262.22	8.2	21.32	0.438	0.732	0.009	0.01
CS24-16	grt-wm schist (CB)	CS24-16-17	199.99	6.0	22.33	1.069	0.728	0.007	-0.07
CS24-16	grt-wm schist (CB)	CS24-16-18	158.77	3.8	25.36	0.333	0.735	0.008	0.40
CS24-16	grt-wm schist (CB)	CS24-16-19	241.12	7.1	16.87	0.581	0.731	0.008	0.10
CS24-16	grt-wm schist (CB)	CS24-16-20	135.45	2.4	0.06	0.002	0.728	0.005	0.18
CS24-16	grt-wm schist (CB)	CS24-16-21	223.88	6.9	20.24	0.323	0.731	0.007	0.15
CS24-16	grt-wm schist (CB)	CS24-16-22	168.12	4.1	0.05	0.002	0.728	0.004	0.09
CS24-16	grt-wm schist (CB)	CS24-16-23	270.00	9.0	17.91	2.529	0.676	0.083	0.08
CS24-16	grt-wm schist (CB)	CS24-16-24	202.78	5.8	0.07	0.001	0.727	0.005	0.36
CS24-16	grt-wm schist (CB)	CS24-16-25	156.66	3.7	0.04	0.001	0.727	0.004	0.26
CS24-16	grt-wm schist (CB)	CS24-16-26	255.55	8.6	0.15	0.002	0.725	0.005	-0.10
CS24-16	grt-wm schist (CB)	CS24-16-27	218.33	6.3	0.20	0.006	0.729	0.006	0.06
CS24-16	grt-wm schist (CB)	CS24-16-28	140.00	3.0	0.06	0.002	0.722	0.005	0.26
CS24-16	grt-wm schist (CB)	CS24-16-29	244.44	7.4	68.57	1.466	0.741	0.010	0.05

Table S3.1 Analytical results for in situ ⁸⁷Rb/⁸⁶Sr geochronology from the the white mica within CB and CBU samples

Sample Number	Rock Name	Analysis	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
CS24-16	grt-wm schist (CB)	CS24-16-30	170.56	4.6	0.05	0.003	0.725	0.005	0.17
CS24-16	grt-wm schist (CB)	CS24-16-31	284.89	9.9	0.53	0.049	0.728	0.006	0.36
CS24-16	grt-wm schist (CB)	CS24-16-32	201.22	5.2	0.26	0.019	0.724	0.006	-0.20
CS24-16	grt-wm schist (CB)	CS24-16-33	155.01	3.0	0.14	0.004	0.726	0.006	0.23
CS24-16	grt-wm schist (CB)	CS24-16-34	261.77	8.8	0.18	0.008	0.728	0.004	0.15
CS24-16	grt-wm schist (CB)	CS24-16-35	207.12	6.1	0.11	0.002	0.726	0.004	-0.05
CS24-16	grt-wm schist (CB)	CS24-16-36	140.66	2.7	0.04	0.002	0.728	0.006	-0.17
CS24-16	grt-wm schist (CB)	CS24-16-37	249.91	7.9	0.09	0.007	0.723	0.005	0.10
CS24-16	grt-wm schist (CB)	CS24-16-38	173.77	4.8	0.15	0.007	0.730	0.006	-0.04
CS24-16	grt-wm schist (CB)	CS24-16-39	271.22	9.2	28.77	0.958	0.735	0.009	0.23
CS24-16	grt-wm schist (CB)	CS24-16-40	198.67	5.7	0.15	0.005	0.723	0.006	0.15
CS24-16	grt-wm schist (CB)	CS24-16-41	157.44	3.4	0.15	0.005	0.726	0.006	0.09
CS24-16	grt-wm schist (CB)	CS24-16-42	253.11	8.1	0.48	0.009	0.727	0.007	0.41
CS24-16	grt-wm schist (CB)	CS24-16-43	220.00	7.0	0.10	0.002	0.729	0.005	0.20
CS24-16	grt-wm schist (CB)	CS24-16-44	134.34	2.3	39.06	0.457	0.731	0.008	0.36
CS24-16	grt-wm schist (CB)	CS24-16-45	240.12	7.1	29.42	0.788	0.724	0.007	-0.10
CS24-16	grt-wm schist (CB)	CS24-16-46	172.99	5.0	22.00	0.307	0.736	0.010	0.57
CS24-16	grt-wm schist (CB)	CS24-16-47	276.66	9.7	16.50	0.207	0.732	0.007	0.15
CS24-16	grt-wm schist (CB)	CS24-16-48	200.01	5.0	0.07	0.001	0.730	0.005	0.05
CS24-16	grt-wm schist (CB)	CS24-16-49	158.77	3.8	0.28	0.006	0.731	0.006	-0.04
CS24-16	grt-wm schist (CB)	CS24-16-50	254.55	8.6	0.04	0.001	0.725	0.005	0.25
CS24-16	grt-wm schist (CB)	CS24-16-51	220.22	6.2	0.19	0.004	0.731	0.007	0.25
CS24-16	grt-wm schist (CB)	CS24-16-52	137.89	2.9	0.14	0.003	0.730	0.005	0.38
CS24-16	grt-wm schist (CB)	CS24-16-53	244.44	7.4	0.33	0.007	0.727	0.005	0.02
CS24-16	grt-wm schist (CB)	CS24-16-54	169.34	4.3	0.26	0.007	0.728	0.005	-0.17
CS24-16	grt-wm schist (CB)	CS24-16-55	270.00	9.0	15.96	0.215	0.726	0.008	0.16
CS24-16	grt-wm schist (CB)	CS24-16-56	203.78	5.8	0.29	0.005	0.728	0.005	-0.14
CS24-16	grt-wm schist (CB)	CS24-16-57	154.12	3.1	0.22	0.003	0.728	0.006	0.45
CS24-16	grt-wm schist (CB)	CS24-16-58	256.66	8.7	0.24	0.006	0.730	0.005	0.33
CS24-16	grt-wm schist (CB)	CS24-16-59	221.55	6.6	0.07	0.001	0.725	0.005	-0.03
CS24-16	grt-wm schist (CB)	CS24-16-60	136.44	2.4	0.17	0.004	0.723	0.006	0.25
CS24-16	grt-wm schist (CB)	CS24-16-61	248.89	7.9	16.69	0.393	0.726	0.008	0.20
CS24-16	grt-wm schist (CB)	CS24-16-62	171.77	4.8	10.44	0.123	0.722	0.006	0.23
CS24-16	grt-wm schist (CB)	CS24-16-63	272.34	9.3	17.34	0.338	0.727	0.007	0.15
CS24-16	grt-wm schist (CB)	CS24-16-64	197.12	5.1	2.00	0.076	0.724	0.007	0.03
CS24-16	grt-wm schist (CB)	CS24-16-65	156.66	3.7	12.51	0.295	0.722	0.007	0.25
CS24-16	grt-wm schist (CB)	CS24-16-66	250.00	8.0	1.28	0.029	0.719	0.006	0.10
CS24-16	grt-wm schist (CB)	CS24-16-67	222.77	6.8	14.80	0.319	0.729	0.009	0.36
CS24-16	grt-wm schist (CB)	CS24-16-68	140.00	3.0	16.40	0.326	0.731	0.009	0.31
CS24-16	grt-wm schist (CB)	CS24-16-69	243.22	7.2	16.14	0.180	0.727	0.007	0.27
CS24-16	grt-wm schist (CB)	CS24-16-70	170.55	4.6	0.07	0.002	0.726	0.005	0.03
CS24-16	grt-wm schist (CB)	CS24-16-71	269.12	9.1	0.14	0.006	0.723	0.006	0.03
CS24-16	grt-wm schist (CB)	CS24-16-72	217.77	6.8	0.25	0.005	0.724	0.006	0.23
CS24-16	grt-wm schist (CB)	CS24-16-73	168.89	3.9	0.39	0.004	0.730	0.005	-0.14
CS24-16	grt-wm schist (CB)	CS24-16-74	251.44	8.4	0.06	0.002	0.721	0.005	-0.04
CS24-16	grt-wm schist (CB)	CS24-16-75	139.99	3.0	0.03	0.006	0.724	0.006	0.01
CS24-16	grt-wm schist (CB)	CS24-16-76	246.67	7.7	0.08	0.001	0.724	0.005	0.07
CS24-16	grt-wm schist (CB)	CS24-16-77	164.22	4.2	19.37	0.299	0.727	0.008	0.27
CS24-16	grt-wm schist (CB)	CS24-16-78	278.56	9.6	0.16	0.004	0.726	0.005	0.17
CS24-16	grt-wm schist (CB)	CS24-16-79	195.33	5.3	0.17	0.004	0.728	0.007	-0.05
CS24-16	grt-wm schist (CB)	CS24-16-80	158.78	3.8	0.31	0.018	0.729	0.005	0.03
CS24-16	grt-wm schist (CB)	CS24-16-81	253.11	8.1	7.74	1.135	0.735	0.007	0.42
CS24-16	grt-wm schist (CB)	CS24-16-82	219.99	7.0	21.44	0.421	0.733	0.006	0.15
CS24-16	grt-wm schist (CB)	CS24-16-83	135.45	2.4	1.76	0.022	0.720	0.007	0.48
CS24-16	grt-wm schist (CB)	CS24-16-84	248.88	7.9	0.15	0.005	0.721	0.004	0.18
CS24-16	grt-wm schist (CB)	CS24-16-85	174.67	4.7	1.79	0.052	0.728	0.005	0.06
CS24-16	grt-wm schist (CB)	CS24-16-86	270.00	9.0	8.46	0.096	0.724	0.005	0.08
CS24-16	grt-wm schist (CB)	CS24-16-87	202.78	5.8	4.89	0.134	0.732	0.006	0.22
CS24-16	grt-wm schist (CB)	CS24-16-88	153.12	3.1	0.13	0.007	0.713	0.016	0.24
CS24-16	grt-wm schist (CB)	CS24-16-89	256.66	8.7	0.90	0.018	0.722	0.005	0.39
CS24-16	grt-wm schist (CB)	CS24-16-90	221.55	6.6	14.46	0.659	0.724	0.008	0.19
CS24-16	grt-wm schist (CB)	CS24-16-91	136.44	2.4	0.18	0.003	0.726	0.004	0.15
CS24-16	grt-wm schist (CB)	CS24-16-92	247.89	7.9	0.18	0.009	0.722	0.005	0.06
CS24-16	grt-wm schist (CB)	CS24-16-93	171.77	4.8	0.22	0.011	0.723	0.005	-0.08
CS24-16	grt-wm schist (CB)	CS24-16-94	272.34	9.3	11.65	0.247	0.728	0.006	0.39
CS24-16	grt-wm schist (CB)	CS24-16-95	196.12	5.1	9.48	0.215	0.727	0.009	0.19
CS24-16	grt-wm schist (CB)	CS24-16-96	155.66	3.7	4.16	0.199	0.725	0.008	0.17
CS24-16	grt-wm schist (CB)	CS24-16-97	249.00	8.0	4.65	0.047	0.729	0.005	0.28
CS24-16	grt-wm schist (CB)	CS24-16-98	220.77	6.8	13.21	0.326	0.720	0.009	0.16
CS24-16	grt-wm schist (CB)	CS24-16-99	139.00	3.0	10.79	0.241	0.730	0.007	0.26
CS24-16	grt-wm schist (CB)	CS24-16-100	242.22	7.2	12.53	0.274	0.725	0.008	0.08
CS24-16	grt-wm schist (CB)	CS24-16-101	169.55	4.6	9.94	0.566	0.735	0.007	0.15
CS24-16	grt-wm schist (CB)	CS24-16-102	268.12	9.1	24.31	0.378	0.730	0.007	0.44
CS24-16	grt-wm schist (CB)	CS24-16-103	214.88	6.9	0.10	0.005	0.719	0.014	0.16
CS24-16	grt-wm schist (CB)	CS24-16-104	176.44	3.4	8.02	0.287	0.729	0.012	-0.03
CS24-16	grt-wm schist (CB)	CS24-16-105	273.22	9.2	15.15	0.478	0.723	0.006	-0.05
CS24-16	grt-wm schist (CB)	CS24-16-106	142.78	2.8	7.32	0.117	0.720	0.008	0.26
CS24-16	grt-wm schist (CB)	CS24-16-107	231.11	7.1	15.89	0.317	0.720	0.007	0.23
CS24-16	grt-wm schist (CB)	CS24-16-108	164.56	4.6	12.82	0.640	0.728	0.013	0.36
CS24-16	grt-wm schist (CB)	CS24-16-109	258.99	9.0	0.10	0.005	0.719	0.005	-0.02
CS24-16	grt-wm schist (CB)	CS24-16-110	195.66	5.7	0.06	0.002	0.724	0.005	-0.09
CS24-16	grt-wm schist (CB)	CS24-16-111	153.12	3.1	19.74	0.917	0.746	0.072	0.47
CS24-16	grt-wm schist (CB)	CS24-16-112	247.44	7.4	0.08	0.001	0.727	0.005	0.18
CS24-16	grt-wm schist (CB)	CS24-16-113	138.99	3.0	0.21	0.004	0.727	0.005	0.51
CS24-16	grt-wm schist (CB)	CS24-16-114	279.56	9.6	18.77	0.651	0.720	0.009	0.40
CS24-16	grt-wm schist (CB)	CS24-16-115	206.00	6.0	0.29	0.126	0.715	0.013	0.19
CS24-16	grt-wm schist (CB)	CS24-16-116	174.89	4.9	0.47	0.008	0.728	0.005	0.31
CS24-16	grt-wm schist (CB)	CS24-16-117	262.22	8.2	14.04	0.205	0.727	0.007	0.08
CS24-16	grt-wm schist (CB)	CS24-16-118	199.99	6.0	0.04	0.001	0.722	0.005	0.06
CS24-16	grt-wm schist (CB)	CS24-16-119	158.77	3.8	0.07	0.001	0.725	0.005	0.00

Table S3.1 Analytical results for in situ ⁸⁷Rb/⁸⁶Sr geochronology from the the white mica within CB and CBU samples

Sample Number	Rock Name	Analysis	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
CS24-16	grt-wm schist (CB)	CS24-16-120	241.12	7.1	3.46	0.051	0.731	0.006	0.49
CS24-20	grt-wm schist (CBU)	CS24-20-1	130.53	3.5	37.61	1.106	0.711	0.010	0.15
CS24-20	grt-wm schist (CBU)	CS24-20-2	198.44	6.3	63.78	1.630	0.729	0.012	0.30
CS24-20	grt-wm schist (CBU)	CS24-20-3	276.12	3.1	411.99	12.745	0.913	0.034	0.61
CS24-20	grt-wm schist (CBU)	CS24-20-4	143.56	9.6	63.44	0.874	0.745	0.014	0.16
CS24-20	grt-wm schist (CBU)	CS24-20-5	254.88	2.8	47.34	1.194	0.717	0.010	0.28
CS24-20	grt-wm schist (CBU)	CS24-20-6	169.77	7.9	31.85	0.824	0.721	0.007	0.38
CS24-20	grt-wm schist (CBU)	CS24-20-7	231.99	4.7	40.88	0.959	0.725	0.010	0.29
CS24-20	grt-wm schist (CBU)	CS24-20-8	187.33	8.2	81.24	2.055	0.735	0.013	0.42
CS24-20	grt-wm schist (CBU)	CS24-20-9	262.44	5.8	68.33	1.561	0.721	0.011	0.21
CS24-20	grt-wm schist (CBU)	CS24-20-10	152.12	4.0	68.47	1.232	0.726	0.010	0.18
CS24-20	grt-wm schist (CBU)	CS24-20-11	279.66	7.1	17.45	0.325	0.705	0.011	0.43
CS24-20	grt-wm schist (CBU)	CS24-20-12	205.77	2.4	38.17	1.656	0.717	0.012	0.16
CS24-20	grt-wm schist (CBU)	CS24-20-13	168.44	9.0	92.31	3.618	0.747	0.024	0.33
CS24-20	grt-wm schist (CBU)	CS24-20-14	243.12	6.6	22.72	0.490	0.708	0.010	-0.21
CS24-20	grt-wm schist (CBU)	CS24-20-15*	0.30	4.9	45.65	1.093	0.727	0.010	0.56
CS24-20	grt-wm schist (CBU)	CS24-20-16	271.55	8.7	78.23	1.465	0.737	0.014	0.50
CS24-20	grt-wm schist (CBU)	CS24-20-17	220.88	5.2	57.07	0.822	0.720	0.013	0.23
CS24-20	grt-wm schist (CBU)	CS24-20-18	157.44	3.7	52.12	0.743	0.737	0.012	0.53
CS24-20	grt-wm schist (CBU)	CS24-20-19	249.77	7.8	24.19	0.496	0.717	0.008	0.20
CS24-20	grt-wm schist (CBU)	CS24-20-20	181.66	3.0	62.02	1.048	0.740	0.009	0.44
CS24-20	grt-wm schist (CBU)	CS24-20-21	264.99	6.9	120.41	2.427	0.742	0.017	0.39
CS24-20	grt-wm schist (CBU)	CS24-20-22	173.22	4.3	86.24	2.536	0.731	0.014	0.22
CS24-20	grt-wm schist (CBU)	CS24-20-23	238.78	9.1	39.16	1.474	0.730	0.010	0.19
CS24-20	grt-wm schist (CBU)	CS24-20-24	150.33	5.8	117.48	2.558	0.765	0.016	0.45
CS24-20	grt-wm schist (CBU)	CS24-20-25	283.12	3.1	54.46	1.056	0.715	0.012	0.55
CS24-20	grt-wm schist (CBU)	CS24-20-26	212.66	8.4	58.62	1.022	0.733	0.012	0.37
CS24-20	grt-wm schist (CBU)	CS24-20-27	166.89	6.2	94.94	2.420	0.751	0.013	0.39
CS24-20	grt-wm schist (CBU)	CS24-20-28	257.00	2.6	77.53	2.620	0.730	0.014	-0.06
CS24-20	grt-wm schist (CBU)	CS24-20-29	194.77	8.0	28.93	0.879	0.715	0.009	-0.01
CS24-20	grt-wm schist (CBU)	CS24-20-30	139.44	4.8	18.18	0.844	0.704	0.028	0.16
CS24-20	grt-wm schist (CBU)	CS24-20-31	268.88	9.7	56.61	0.969	0.727	0.010	0.34
CS24-20	grt-wm schist (CBU)	CS24-20-32	201.22	5.1	66.08	3.353	0.726	0.013	0.14
CS24-20	grt-wm schist (CBU)	CS24-20-33	175.67	3.4	55.17	1.749	0.725	0.011	0.30
CS24-20	grt-wm schist (CBU)	CS24-20-34	245.99	8.8	96.70	3.651	0.753	0.016	0.02
CS24-20	grt-wm schist (CBU)	CS24-20-35	160.44	6.9	63.95	1.545	0.725	0.012	0.41
CS24-20	grt-wm schist (CBU)	CS24-20-36	278.77	3.0	41.00	0.588	0.725	0.008	0.29
CS24-20	grt-wm schist (CBU)	CS24-20-37	217.34	7.2	18.56	1.759	0.700	0.058	0.35
CS24-20	grt-wm schist (CBU)	CS24-20-38	182.55	4.6	37.11	0.939	0.708	0.010	0.48
CS24-20	grt-wm schist (CBU)	CS24-20-39	259.88	9.3	80.98	1.991	0.756	0.014	0.45
CS24-20	grt-wm schist (CBU)	CS24-20-40	147.99	5.7	41.43	1.500	0.725	0.012	0.48
CS24-20	grt-wm schist (CBU)	CS24-20-41	273.44	3.1	51.10	1.515	0.725	0.014	0.28
CS24-20	grt-wm schist (CBU)	CS24-20-42	209.12	8.1	67.68	2.059	0.729	0.015	0.10
CS24-20	grt-wm schist (CBU)	CS24-20-43	171.66	6.8	137.21	2.801	0.771	0.015	0.27
CS24-20	grt-wm schist (CBU)	CS24-20-44	240.89	2.7	160.96	5.308	0.771	0.019	0.24
CS24-20	grt-wm schist (CBU)	CS24-20-45	155.77	7.9	38.46	0.584	0.713	0.011	0.50
CS24-20	grt-wm schist (CBU)	CS24-20-46	281.33	4.2	45.89	1.158	0.713	0.016	0.16
CS24-20	grt-wm schist (CBU)	CS24-20-47	224.12	9.6	23.74	0.576	0.717	0.010	0.13
CS24-20	grt-wm schist (CBU)	CS24-20-48	163.55	5.0	7.30	0.612	0.690	0.025	0.62
CS24-20	grt-wm schist (CBU)	CS24-20-49	251.88	3.8	16.39	0.453	0.709	0.013	0.50
CS24-20	grt-wm schist (CBU)	CS24-20-50	189.44	8.4	54.55	1.839	0.718	0.017	0.30
CS24-20	grt-wm schist (CBU)	CS24-20-51	266.77	7.0	22.07	0.469	0.708	0.012	0.26
CS24-20	grt-wm schist (CBU)	CS24-20-52	176.00	2.3	27.87	0.956	0.717	0.009	-0.03
CS24-20	grt-wm schist (CBU)	CS24-20-53	236.88	7.1	49.86	1.089	0.709	0.018	0.30
CS24-20	grt-wm schist (CBU)	CS24-20-54	149.55	5.0	35.66	0.911	0.719	0.009	0.04
CS24-20	grt-wm schist (CBU)	CS24-20-55	280.12	9.0	29.51	1.117	0.720	0.010	0.20
CS24-20	grt-wm schist (CBU)	CS24-20-56	214.77	5.8	80.10	1.307	0.728	0.015	0.51
CS24-20	grt-wm schist (CBU)	CS24-20-57	168.44	3.2	16.31	0.665	0.708	0.016	0.16
CS24-20	grt-wm schist (CBU)	CS24-20-58	247.89	8.7	48.25	1.513	0.721	0.010	-0.11
CS24-20	grt-wm schist (CBU)	CS24-20-59	192.66	6.6	25.57	0.784	0.717	0.011	0.11
CS24-20	grt-wm schist (CBU)	CS24-20-60	135.77	2.4	5.40	0.058	0.711	0.005	0.23
CS24-20	grt-wm schist (CBU)	CS24-20-61	270.44	7.9	34.19	0.566	0.728	0.008	0.28
CS24-20	grt-wm schist (CBU)	CS24-20-62	203.12	4.8	42.99	1.047	0.725	0.009	0.18
CS24-20	grt-wm schist (CBU)	CS24-20-63	174.66	9.3	71.93	1.079	0.730	0.012	0.25
CS24-20	grt-wm schist (CBU)	CS24-20-64	244.99	5.1	22.01	0.784	0.717	0.009	0.03
CS24-20	grt-wm schist (CBU)	CS24-20-65	158.44	3.7	37.63	1.093	0.731	0.012	0.39
CS24-20	grt-wm schist (CBU)	CS24-20-66	277.77	8.0	52.68	1.130	0.728	0.010	0.08
CS24-20	grt-wm schist (CBU)	CS24-20-67	219.34	6.8	101.54	4.993	0.740	0.018	0.13
CS24-20	grt-wm schist (CBU)	CS24-20-68	180.55	3.0	447.08	16.148	0.955	0.033	0.38
CS24-20	grt-wm schist (CBU)	CS24-20-69	258.88	7.2	31.94	1.244	0.717	0.010	0.22
CS24-20	grt-wm schist (CBU)	CS24-20-70*	-0.01	4.6	94.72	2.916	0.746	0.011	0.41

Table S3.2. Reference material data for in situ $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology

Analysis	x (um)	y (um)	Rb (ppm)	Sr (ppm)	Rb $^{87}/\text{Sr}^{86}$	2 σ (%)	Sr $^{87}/\text{Sr}^{86}$	2 σ (%)	rho
G_NIST612-1	41134.8	23679.2	31.4	77.6	1.211	1.0	0.7109	0.9	0.51
G_NIST612-2	41227.9	23663.7	30.8	76.4	1.213	0.8	0.7108	0.8	0.32
G_NIST612-3	41327.7	23648.1	30.2	75.7	1.209	1.2	0.7104	1.0	0.48
G_NIST612-4	41429.6	23628.2	29.9	75.3	1.193	0.9	0.7113	0.9	0.38
G_NIST612-5	41531.6	23617.1	29.8	74.7	1.183	1.1	0.7076	0.8	0.05
G_NIST612-6	41633.5	23586.1	30.0	75.3	1.193	0.9	0.7118	1.0	0.24
G_NIST612-7	41731.1	23572.8	29.8	75.0	1.182	1.1	0.7039	0.8	0.08
G_NIST612-8	41833.0	23552.8	29.8	73.8	1.198	1.3	0.7105	0.8	0.08
G_NIST612-9	41937.2	23535.1	29.4	74.3	1.212	1.1	0.7169	1.0	0.46
G_NIST612-10	42032.5	23506.3	29.3	74.0	1.224	1.2	0.7081	0.9	0.10
G_NIST612-11	41185.7	23759.1	29.7	74.1	1.186	0.9	0.7130	0.8	0.10
G_NIST612-12	41290.9	23738.4	29.9	75.8	1.204	1.2	0.7066	0.8	0.21
G_NIST612-13	41395.2	23720.7	29.8	75.1	1.201	0.8	0.7102	0.9	0.37
G_NIST612-14	41487.6	23701.1	29.9	74.2	1.195	1.0	0.7089	0.7	0.18
G_NIST612-15	41600.7	23681.4	29.8	74.4	1.192	1.1	0.7115	0.8	0.24
G_NIST612-16	41701.0	23665.7	29.3	74.6	1.172	1.0	0.7027	0.9	0.40
G_NIST612-17	41793.4	23646.0	29.5	74.5	1.192	1.2	0.7095	1.0	0.27
G_NIST612-18	41886.3	23630.1	29.2	74.2	1.188	1.0	0.7102	0.8	0.07
G_NIST612-19	41988.6	23611.4	30.0	74.6	1.175	0.9	0.7063	0.8	0.36
G_NIST612-20	42081.0	23592.7	29.6	73.7	1.197	1.3	0.7033	1.2	0.45
G_NIST612-21	42132.1	23516.0	29.4	74.3	1.210	1.1	0.7075	1.1	0.30
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Mica Fe-1	64857.2	35181.0	1300	2.0	1669.913	4.7	7.96	6.4	0.77
Mica Fe-2	64959.2	35134.7	1450	1.9	1698.986	2.2	7.88	1.8	0.83
Mica Fe-3	65083.3	35087.6	1370	1.5	1392.101	3.5	7.00	2.6	0.67
Mica Fe-4	65196.8	35035.8	1380	1.7	1519.389	2.5	7.44	2.0	0.81
Mica Fe-5	65313.5	34992.4	1500	2.1	1456.416	2.8	7.37	2.0	0.81
Mica Fe-6	64937.9	35228.1	1540	2.2	1731.012	2.3	8.36	2.0	0.59
Mica Fe-7	65045.9	35182.2	1410	2.2	1609.887	1.9	7.94	1.6	0.70
Mica Fe-8	65172.7	35133.5	1380	1.9	1760.724	2.3	8.39	2.5	0.83
Mica Fe-9	65281.9	35093.8	1290	2.1	1509.837	2.3	7.53	2.1	0.86
Mica Fe-10	65391.1	35051.6	1500	2.1	1558.502	2.3	7.70	2.0	0.68
Mica Fe-11	65364.0	35148.2	1500	1.7	1692.916	2.1	8.00	2.4	0.80
Mica Fe-12	65266.4	35200.9	1430	1.8	1635.027	2.0	7.81	2.0	0.90
Mica Fe-13	65164.9	35237.8	1460	2.0	1603.008	2.4	7.56	2.4	0.82
Mica Fe-14	65080.5	35276.1	1510	1.9	1493.767	3.6	7.40	3.3	0.95
Mica Fe-15	64989.5	35321.3	1560	1.8	1658.495	2.6	7.97	2.6	0.78
Mica Fe-16	64935.8	35407.4	1500	1.7	1600.887	2.9	7.53	2.7	0.74
Mica Fe-17	65033.3	35411.3	1340	1.8	1673.522	2.1	7.93	2.2	0.73
Mica Fe-18	65119.0	35370.5	1410	2.1	1559.637	2.3	7.58	2.1	0.86
Mica Fe-19	65206.1	35324.3	1500	2.1	1543.507	1.5	7.72	1.5	0.78
Mica Fe-20	65299.7	35284.8	1420	2.0	1456.449	2.1	7.37	2.2	0.86
Mica Fe-21	65384.1	35243.9	1460	2.0	1547.949	2.2	7.70	2.0	0.84
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<i>317 ± 33 Ma (MSWD = 6.6); expected = ca. 305.4 Rosel and Zack, 2022</i>									
Mica MA1-1	45440.9	6863.5	532	1.8	582.278	2.0	3.8904	1.6	0.51
Mica MA1-2	45520.2	6790.0	488	1.7	593.692	2.7	3.9288	1.9	0.73
Mica MA1-3	45609.2	6726.1	520	1.2	592.799	2.5	3.8915	1.5	0.52
Mica MA1-4	45705.9	6662.3	556	1.9	575.141	2.2	3.8292	1.8	0.48
Mica MA1-5	45812.2	6594.6	600	2.0	580.515	2.5	3.9286	1.5	0.30
Mica MA1-6	45894.1	6529.0	543	1.7	594.707	2.5	3.8499	1.9	0.37
Mica MA1-7	45965.7	6457.4	578	1.7	600.857	2.9	3.9188	1.9	0.36
Mica MA1-8	46035.8	6390.2	598	1.8	610.055	2.4	3.8305	2.3	0.66
Mica MA1-9	46129.8	6321.6	460	1.6	635.152	2.6	3.9917	2.0	0.49
Mica MA1-10	46205.9	6264.9	471	1.8	683.094	3.2	4.1453	2.1	0.68
Mica MA1-11	45423.4	6989.9	484	2.0	600.991	2.4	3.8728	1.7	0.39
Mica MA1-12	45512.0	6942.8	471	1.8	572.034	2.2	3.8336	2.3	0.67
Mica MA1-13	45593.5	6875.8	511	1.7	558.692	3.4	3.9723	4.0	0.68
Mica MA1-14	45669.5	6819.7	510	1.8	612.128	2.6	3.8405	1.5	0.44
Mica MA1-15	45761.8	6761.8	504	1.4	615.417	2.7	3.8407	1.6	0.64
Mica MA1-16	45846.8	6703.9	508	1.6	615.433	2.7	3.8653	2.0	0.60
Mica MA1-17	45939.1	6642.4	486	2.0	607.531	2.9	3.8189	1.7	0.50
Mica MA1-18	46013.2	6576.1	520	1.7	598.382	2.6	3.8629	2.1	0.56
Mica MA1-19	46080.1	6498.3	556	1.9	566.524	3.1	3.8543	2.6	0.79
Mica MA1-20	46148.9	6433.1	560	1.8	626.194	2.7	3.9774	2.0	0.45
Mica MA1-21	46237.6	6364.4	525	1.9	639.618	1.8	4.0329	2.0	0.15
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<i>364 ± 11 Ma (MSWD = 3.4); expected = ca. 350 A. Camacho Pers. Comm.</i>									
Mica Mg-1	30703.6	32401.5	920	11.0	158.405	1.5	1.8481	0.9	0.39
Mica Mg-2	30819.9	32430.9	885	14.0	156.248	1.1	1.8395	0.9	0.31
Mica Mg-3	30933.5	32463.1	889	14.0	160.071	1.2	1.8615	0.9	0.38
Mica Mg-4	31069.5	32492.6	893	15.0	155.563	1.3	1.8649	1.0	0.49
Mica Mg-5	31204.1	32523.4	920	12.0	152.228	1.1	1.8450	1.1	0.38

Table S3.2. Reference material data for in situ $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology

Analysis	x (um)	y (um)	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
Mica Mg-6	31317.6	32557.1	965	13.0	155.837	1.3	1.8358	1.3	0.65
Mica Mg-7	31445.2	32599.1	941	13.0	153.624	1.3	1.8515	1.0	0.13
Mica Mg-8	30731.6	32498.2	866	13.0	155.259	1.5	1.8594	1.2	0.29
Mica Mg-9	30849.4	32536.0	900	13.0	151.625	1.2	1.8707	1.2	0.54
Mica Mg-10	30965.7	32572.5	850	12.0	154.805	1.4	1.8491	0.9	0.61
Mica Mg-11	31100.3	32599.1	910	11.0	159.705	1.9	1.8505	1.1	0.42
Mica Mg-12	31237.7	32632.8	883	11.0	155.451	1.5	1.8408	1.0	0.52
Mica Mg-13	31347.1	32667.8	924	11.0	155.542	1.2	1.8448	1.1	0.64
Mica Mg-14	31254.5	32733.7	910	11.0	156.579	1.6	1.8402	0.9	0.06
Mica Mg-15	31141.0	32683.2	870	14.0	154.281	1.2	1.8441	1.0	0.32
Mica Mg-16	31016.2	32666.4	830	15.0	152.301	1.4	1.8461	1.1	0.40
Mica Mg-17	30894.2	32634.2	888	12.0	155.021	1.6	1.8507	1.1	0.33
Mica Mg-18	30762.4	32596.3	845	12.0	156.575	2.1	1.8400	1.3	0.40
Mica Mg-19	30650.3	32565.5	868	12.0	158.356	2.3	1.8558	1.2	0.14
Mica Mg-20	30616.6	32460.3	972	13.0	154.238	1.5	1.8385	0.9	0.39
<i>501 ± 20 Ma (MSWD = 0.98); expected = 519 ± 7 Ma Hogmalm et al. 2017</i>									
LaPosta-1	58555.2	13371.5	375	2.5	602.871	3.2	1.5173	3.1	0.64
LaPosta-2	58480.7	13464.6	390	3.4	479.227	6.1	1.3332	3.2	0.77
LaPosta-3	58408.3	13557.7	400	2.7	584.970	3.6	1.5206	3.8	0.69
LaPosta-4	58335.8	13667.4	382	2.7	10.109	2.5	0.7281	1.4	0.25
LaPosta-5	58265.5	13776.0	378	2.6	561.555	5.2	1.4776	4.2	0.78
LaPosta-6	58197.2	13850.5	385	2.4	614.202	3.8	1.5554	3.6	0.65
LaPosta-7	58128.9	13939.4	386	2.3	249.349	4.0	1.0252	2.9	0.52
LaPosta-8	58066.9	14020.1	390	2.5	1303.168	3.2	2.5956	3.7	0.63
LaPosta-9	59850.2	14188.1	387	2.9	1453.969	4.1	2.7107	4.0	0.76
LaPosta-10	59947.7	14223.6	356	3.2	1395.213	3.7	2.5912	4.1	0.75
LaPosta-11	60104.3	14265.0	365	3.0	461.416	3.3	1.3295	4.1	0.74
LaPosta-12	59817.7	14291.6	362	2.5	689.904	4.4	1.6458	3.4	0.69
LaPosta-13	59915.2	14341.8	365	2.4	1023.592	3.6	2.0142	4.2	0.75
LaPosta-14	60036.4	14392.0	375	2.6	893.153	3.4	1.8808	3.6	0.67
LaPosta-15	59805.9	14439.3	378	2.8	778.037	3.8	1.7047	3.4	0.74
LaPosta-16	59924.1	14471.8	379	2.8	563.200	2.5	1.4879	3.5	0.48
LaPosta-17	58601.3	16114.2	380	2.7	847.822	3.5	1.8552	3.2	0.80
LaPosta-18	58673.7	16221.8	394	2.4	548.505	2.5	1.4224	3.8	0.74
LaPosta-19	58468.9	16246.7	378	2.5	535.713	3.2	1.4378	3.5	0.67
LaPosta-20	58545.4	16329.4	392	2.9	88.673	12.2	0.8217	2.3	0.56
LaPosta-21	58570.3	16221.8	391	3.0	570.361	2.5	1.4653	3.3	0.57
<i>96 ± 4 Ma (MSWD = 0.53); expected = 91.6 ± 1.2 Ma Zack & Hogmalm 2016</i>									
Mica_1B-1	41438.0	14625.9	185	5.3	156.504	2.2	2.8876	1.5	0.69
Mica_1B-2	41543.6	14567.9	192	6.2	144.168	1.8	2.7089	1.6	0.59
Mica_1B-3	41605.6	14497.6	167	4.9	149.378	2.5	2.7359	2.1	0.70
Mica_1B-4	41711.2	14423.1	180	5.5	150.666	2.2	2.7698	1.9	0.73
Mica_1B-5	41818.8	14350.7	173	5.5	171.613	2.2	3.0646	2.1	0.79
Mica_1B-6	43381.8	15914.6	192	7.3	86.862	1.5	1.9412	1.4	0.51
Mica_1B-7	43450.5	15837.1	195	6.2	61.956	1.7	1.5912	1.3	0.38
Mica_1B-8	43497.1	15746.2	180	7.5	52.926	1.7	1.4720	1.3	0.47
Mica_1B-9	43568.0	15664.2	178	6.4	50.007	1.4	1.4393	1.4	0.55
Mica_1B-10	43645.6	15566.6	175	6.8	47.654	1.5	1.3993	1.4	0.61
Mica_1B-11	38984.5	14293.3	169	4.7	102.963	2.5	2.0922	1.6	0.70
Mica_1B-12	39091.5	14293.3	194	5.8	111.717	2.1	2.2019	1.6	0.55
Mica_1B-13	39189.0	14274.3	191	6.1	126.008	2.7	2.3399	2.0	0.69
Mica_1B-14	39324.4	14269.6	190	5.3	62.270	4.0	1.5574	3.1	0.89
Mica_1B-15	39426.7	14267.2	170	5.8	120.718	2.1	2.3023	1.9	0.66
Mica_1B-16	40156.9	15270.8	178	6.3	45.747	9.9	1.4672	11.2	0.62
Mica_1B-17	40285.9	15199.4	175	6.3	48.269	19.7	1.5389	13.9	0.38
Mica_1B-18	40368.2	15339.4	174	6.2	85.379	18.8	3.5267	17.4	0.52
Mica_1B-19	40236.5	15377.8	182	6.4	70.107	24.0	3.0921	23.0	0.36
Mica_1B-20	40225.5	15490.3	192	7.0	54.563	19.5	2.8336	21.1	0.35
Mica_1B-21	40329.8	15451.9	190	6.7	85.460	25.3	5.1957	47.2	0.51
<i>984 ± 23 Ma (MSWD = 1.6, n= 16/21); expected 990 ± 5 Ma Camacho et al. 2012</i>									
Mica_1O-1	47363.0	15024.8	375	1.8	1140.597	3.8	16.4148	3.7	0.94
Mica_1O-2	47467.5	15046.1	366	1.7	1339.914	4.2	18.8255	4.3	0.96
Mica_1O-3	47521.6	15137.0	390	1.6	517.495	3.1	7.7656	2.8	0.91
Mica_1O-4	47390.1	15146.7	391	1.8	2232.553	6.1	32.3538	6.6	0.97
Mica_1O-5	47295.3	15222.1	357	2.0	1331.367	4.2	19.8138	4.5	0.95
Mica_1O-6	47411.4	15264.7	381	1.5	1781.654	6.2	24.7095	5.7	0.93
Mica_1O-7	48954.6	13425.5	348	1.4	1118.817	2.6	16.2439	3.0	0.81
Mica_1O-8	48855.1	13496.1	346	1.6	1012.617	5.2	15.3465	5.6	0.94
Mica_1O-9	48775.4	13586.5	345	1.7	1088.845	3.9	15.6910	3.9	0.95
Mica_1O-10	48695.8	13696.9	379	1.5	993.377	4.5	14.7297	5.0	0.97

Table S3.2. Reference material data for in situ $^{87}\text{Rb}/^{86}\text{Sr}$ geochronology

Analysis	x (um)	y (um)	Rb (ppm)	Sr (ppm)	Rb ⁸⁷ /Sr ⁸⁶	2σ (%)	Sr ⁸⁷ /Sr ⁸⁶	2σ (%)	rho
Mica_1O-11	48592.7	13778.4	382	1.4	387.473	3.1	6.0784	2.6	0.85
Mica_1O-12	48361.6	16042.0	359	1.6	1332.657	5.4	19.1660	5.1	0.96
Mica_1O-13	48458.6	16090.5	352	1.5	982.321	4.3	14.2662	4.9	0.86
Mica_1O-14	48384.6	16167.0	375	1.5	0.383	1.4	0.7091	1.2	0.17
Mica_1O-15	48277.3	16118.5	363	1.5	129.535	23.5	2.5247	17.1	0.99
Mica_1O-16	48257.8	17982.7	365	1.5	918.562	5.2	13.4555	4.9	0.96
Mica_1O-17	48342.8	17930.6	391	1.6	1032.058	5.0	14.6075	5.4	0.92
Mica_1O-18	48427.9	17873.0	399	1.6	1007.841	5.2	14.4671	4.7	0.97
Mica_1O-19	48513.0	17818.1	388	1.7	859.310	6.7	12.5616	7.3	0.95
Mica_1O-20	48611.8	17768.7	376	1.5	585.360	5.8	8.9114	6.2	0.98
Mica_1O-21	48710.6	17719.3	389	1.4	440.214	5.0	6.9162	5.2	0.97
<i>985 ± 7.2 Ma (MSWD = 1.3); expected 986 ± 5 Ma Camacho et al. 2012</i>									

Table S4. Compilation of published geochronological ages and associated tectonometamorphic events on Ios, Greece

Age (Ma)	Unit / Structure	Method	Age interpretation	Implication for Ios	References
446 ± 2.3	Cycladic Basement (CB)	zircon U–Pb	Ordovician igneous protolith/dyke crystallization	Oldest well-constrained igneous component recognized in the Ios basement; constrains protolith crystallization.	Flansburg et al. (2019)
330–297	CB + SCSZ	zircon U–Pb; apatite U–Pb	Carboniferous magmatism and Permian thermal/deformation history	Main CB granitoids crystallized at ca. 330–306 Ma. Apatite ages (ca. 305–270 Ma) suggest that some basement/SCSZ mylonitic fabrics preserve evidence of Paleozoic–Permian deformation.	Flansburg et al. (2019, 2026); Andriessen et al. (1987)
237–235; 295–270; 237.2 ± 1.2	CB + CBU (Cycladic Blueschist Unit)	detrital and igneous zircon U–Pb	245–237 Ma: Triassic volcanic protolith crystallization; 295–270 Ma: Permian maximum depositional ages; 237.2 ± 1.2 Ma: Triassic volcanic crystallization	Records Triassic magmatism and volcanism in both the basement and CBU.	Bröcker & Pidgeon (2007); Flansburg et al. (2019); Poulaki et al. (2019)
ca. 65–40	CB + CBU	metamorphic zircon U–Pb; white-mica K–Ar/Ar–Ar	Alpine high-pressure metamorphism and subduction-related recrystallization	Broad M ₁ interval, with commonly reported high-pressure age clusters at ca. 52–48 and 45–38 Ma. Timing remains debated because zircon rims and mica ages may not directly date peak metamorphic assemblages. Potential interval encompassing successive S ₁ –S ₃ fabric development.	Flansburg et al. (2019); Poulaki et al. (2021); Peillod et al. (2024)
ca. 35–30	SCSZ + CBU	white-mica/K-feldspar Ar–Ar	Oligocene retrogression, mica recrystallization, and deformation	Records early retrogression and re-equilibration; proposed early SCSZ activity. Potential interval encompassing successive S ₂ –S ₃ fabric development.	Baldwin & Lister (1998); Forster & Lister (1999, 2005, 2009, 2010); Forster et al. (2009, 2020)
ca. 25–18	HSZ + CB + SCSZ	white-mica Rb–Sr; phengite/white-mica Ar–Ar	Late Oligocene–early Miocene greenschist-facies recrystallization and deformation	Regional ca. 25 Ma Ar ages have been linked to top-to-north overprinting, potentially continuing into waning stages at ca. 18 Ma.	Baldwin & Lister (1998); Forster & Lister (2009, 2010); Thomson et al. (2009); Forster et al. (2020); Tsourtis et al. (2024)
ca. 14–13	CB / SCSZ footwall	K-feldspar Ar–Ar; white-mica Rb–Sr	Late thermal resetting and recrystallization	Suggests thermal or fluid-assisted recrystallization, or late deformation, persisted into the middle Miocene.	Henjes-Kunst & Kreuzer (1982); Baldwin & Lister (1998)
ca. 15–7	Ios dome	zircon fission-track (ZFT); apatite fission-track (AFT); zircon (U–Th)/He (ZHe); apatite (U–Th)/He (AHe)	Low-temperature cooling and final exhumation	Records shallow-crustal cooling and exhumation following ductile deformation.	Thomson et al. (2009); Flansburg et al. (2022)