AN ANALYSIS OF THE FABRIC, MINERAL CHEMISTRY, AND GEOCHRONOLOGY PRESERVED IN WHITE MICA: SYROS, CYCLADES, GREECE

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INTRODUCTION

Varying widely in character, from graphitic schists, to glaucophane dominated blueschists, to albite bearing greenschists, but related by the presence of deformed white mica, samples of quartz-mica schist were collected from diverse locations on Syros for analysis of targeted white mica grains and mica fabrics (Fig 1). White mica grains have various habits that are complexly related to multiple white mica fabrics owing to the intricate nature of grain growth and deformation. This analysis isolates features that are related to distinct white mica growth phases and identifies fabrics that help constrain observable kinematic relationships on Syros.

In addition, the systematic targeting of white mica grains and fabrics, along with the analysis of mineral chemistry, sets the groundwork for future $^{40}Ar/^{39}Ar$ spot-laser dating. Recent advances in $^{40}Ar/^{39}Ar$ dating methods have made it possible to integrate geochronology, fabric analyses and petrology (Müller, 2003). Deformed white mica grains may have chemical variances related to distinct phases of grain growth, and may include microstructures that reset radiogenic ^{40}Ar after initial cooling (*i.e*. kink folds and grain slip surfaces) (Hames and Cheney, 1999). Therefore white mica grains may be used to date post-cooling deformation. This study identifies features to be targeted for $^{40}Ar/^{39}Ar$ spot-laser dating.

Although mechanisms have been proposed for the subduction and exhumation of the Syros rocks, and have been related to fabrics locally observed in the Cyclades, no coherent model for the evolution of Syros or the Cyclades has been accepted by the geologic community. Fabric and microstructural observations together with chemical analyses will provide the framework for more systematic dating of the deformation recorded in the schists of Syros, and will help constrain structural interpretations regarding the geologic evolution of Syros.

METHODS

Sixteen samples collected on Syros were selected for analysis in thin section on the basis of white mica textures and fabrics observed in outcrop and in hand sample. Thin sections were cut perpendicular to foliation and parallel to lineation. Multiple thin sections were cut from samples with multiple lineations.

Thin sections were examined with an optical microscope, with particular attention paid to the occurrence of white mica, to determine mineral characteristics and to gain a better understanding of fabric relationships.

Samples were then analyzed with the SEM-EDS to ascertain mineral chemistry.

PETROGRAPHY

Three distinct habits of mica are noted: fibrous, lath, and tabular. In some samples all three occur, and in others only one. In addition samples may contain complex overprinting of similar mica habits (i.e. a lath defined foliation

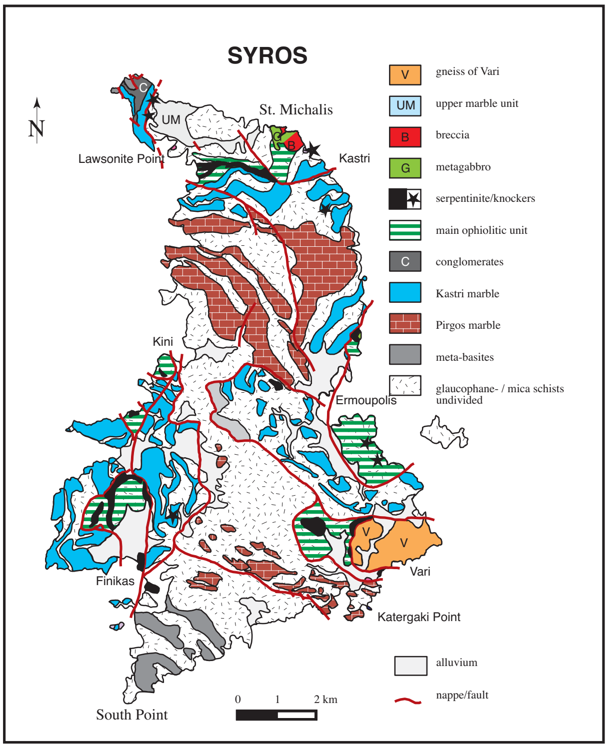


Figure 1: Generalized geology of Syros. Adapted from Hopfer and Schumacher (1997).

overprinted by lath-shaped porphyroblasts) (Fig. 2). A few generalizations can be made:

1. Tabular micas are porphyroblastic, and are pre-, syn-, and post-tectonic.
2. Rock foliations are defined by either lath or fibrous micas.
3. Lath-shaped mica occurs porphyroblastically, both in lenses and as grains cross-cutting the main foliation.
4. Fibrous micas are foliated and are typically crenulated where occurring in lenses.
5. Fibrous and lath-shaped micas occur as inclusions in garnets, and may be foliated or randomly oriented

The majority of samples (12) contain a 'domainal spaced cleavage' after Passchier and Trouw (1996). These fabrics are defined by spaced lens-shaped (1) quartz dominated microlithons and (2) mica dominated microlithons within a quartz-mica groundmass foliation. Groundmass foliations range from parallel to anastomosing after Passchier and Trouw (1996). Quartz dominated lenses consist of a quartz matrix containing lath and tabular porphyroblastic white mica grains oriented sub-perpendicular to the surrounding groundmass foliation. Mica dominated lenses typically contain fibrous crenulated mica fabrics with minor amounts of quartz. Greenschist overprinted samples have similarly spaced lenses containing chlorite grains oriented sub-perpendicular to the surrounding groundmass foliation, as well as lenses containing porphyroblastic albite grains.

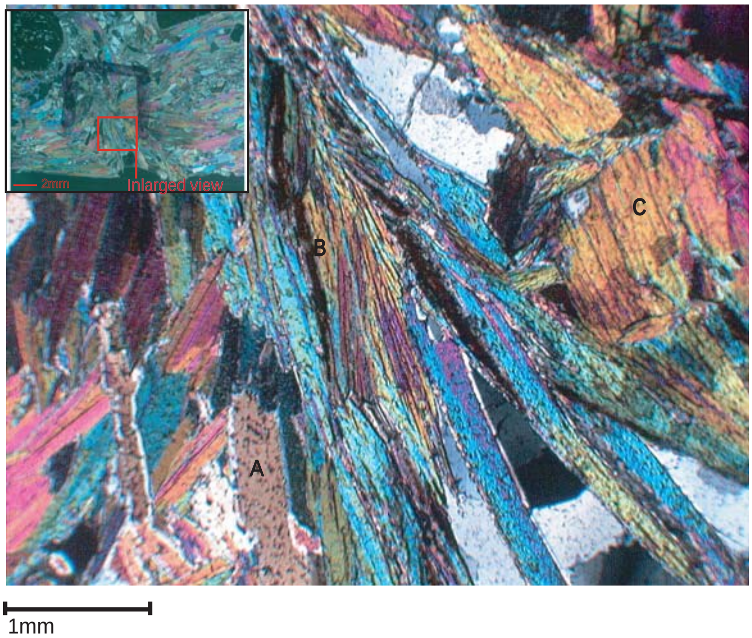
Two samples have penetrative crenulation fabrics. In one sample lath-shaped micas define the foliation and in the other fibrous mica grains define the foliation. In both cases the crenulation deforms all preexisting rock textures. Porphyroblastic paragonite grains overprint the crenulation cleavage at fold hinges.

Two samples of quartz rich schist have S-C fabrics defined by fibrous mica grains. In both samples no other mica texture is present (Fig 3).

MINERAL CHEMISTRY

Phengite and paragonite may occur together within a given fabric over a wide range of bulk compositions due to the nature of the phengite-paragonite solvus (Guidotti and Sassi, 2002). Phengite [$KAl_2AlSi_3O_{10}(OH)_2$ – $K(Fe,Mg)(Al,Fe^{3+})Si_4O_{10}(OH)_2$] is present in all samples and typically occurs as lath-shaped or tabular grains. Paragonite [$NaAl_2AlSi_3O_{10}(OH)_2$] occurs in most but not all samples and grains are generally fibrous, with the important exception of tabular porphyroblasts occurring at the hinges of crenulations in sample SJD-03-06a. The separation of these minerals is key, because paragonites cannot be radiometrically dated, in addition, because paragonite does not take Mg or Fe into the Al^{VI} slot, it is less useful for geobarometry (Guidotti and Sassi, 2000).

In all samples phengite is unzoned. However points of increased aluminoceladonite substitution (Si^{IV} + (Fe^{2+}, Mg) _ Al^{IV} + Al^{VI}) are observed, and may be related to chemical re-equilibration during deformation (Guidotti and Sassi, 2002) (Fig 4, Table 1).



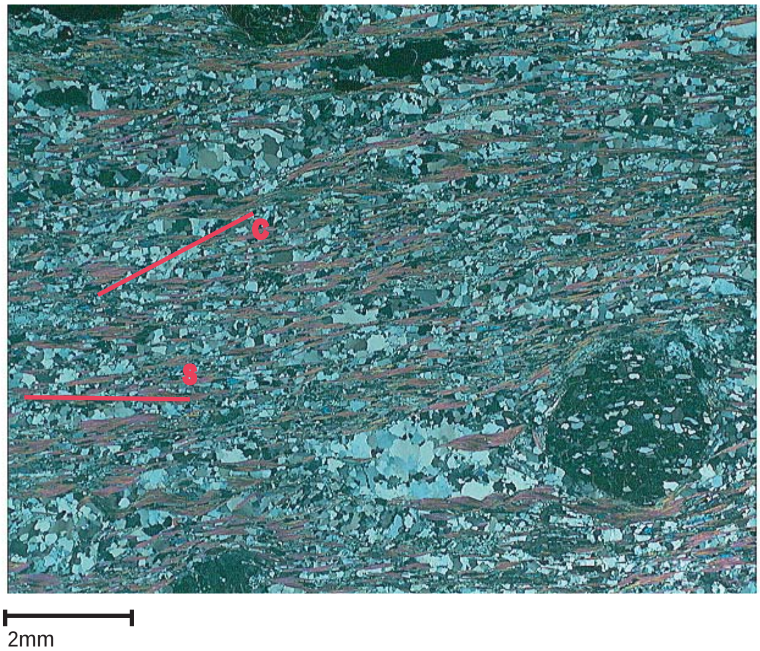


Figure 2: Phengite grains in a cm scale fold (inset) visible in hand sample attest to the complex relationship between grain growth and deformation. (A) lath-shaped porphyroblastic micas crosscutting the folded fabric are aligned sub-parallel to the axial plane of the fold. (B) Smaller lath shaped foliation defining micas are folded and ruptured along intergrain slip-surfaces. (C) Porphyroblastic tabular mica that crosscut and deform type B mica grains. Sample SJD-03-01a. Figure 3: Quartz mica schist sample collected from a meter thick outcrop of schist interbedded with mafic schist. S-C fabric, which is seen in other quartz schists, is top-to-the-right in this sample. SJD-03-34a.

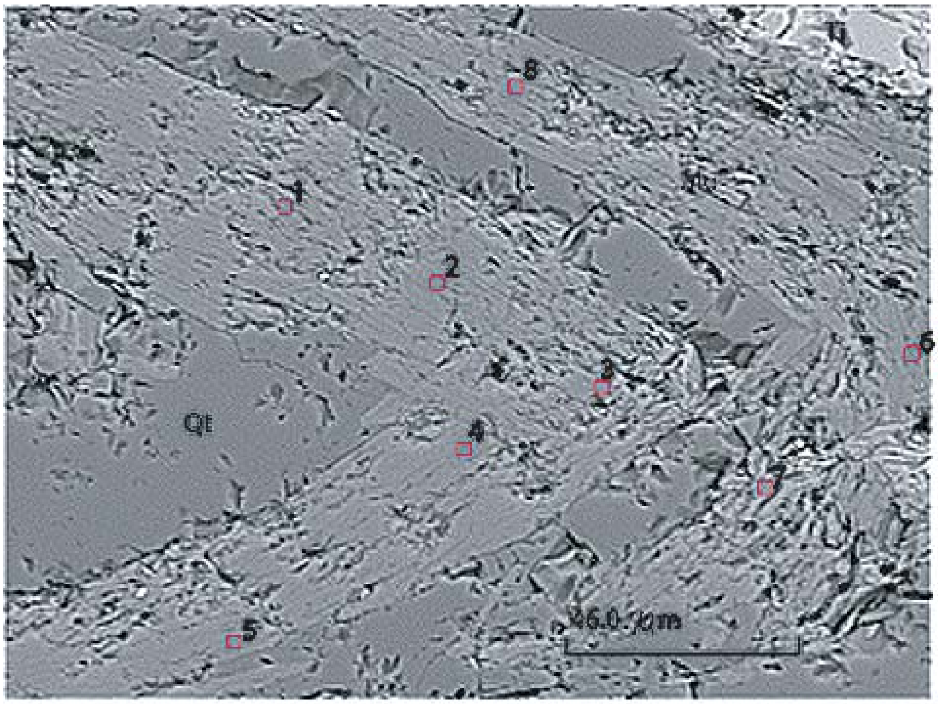


Figure 4: Electron Back-Scatter image of crenulated phengite. Mu= muscovite, Qt = quartz, Ti = titanite. Sample SJD-03-26a.

Table 1: Per formula unit (pfu) measurement of Si, Na, K, and Mg/Mg + Fe (possible barometric control (Guidotti and Sassi, 2000) from targeted spots on a crenulated white mica grain from SJD-03-26a (Fig 4).

Sample SJD-03-26a

	Pfu for Muscovite, O =11			
Target #	Si	Na	K	Mg/Mg +Fe
1	3.424	0.126	0.762	0.728
2	3.467	0.053	0.748	0.777
3	3.548	0.038	0.724	0.765
4				
5	3.434	0.096	0.774	0.781
6	3.430	0.108	0.772	0.788
7	3.382	0.15	0.672	0.748
8	3.404	0.108	0.906	0.727

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