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SERPENTINITE CARBONATION IN THE POLLINO MASSIF (SOUTHERN ITALY) FOR CO_2 SEQUESTRATION

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INTRODUCTION

Anthropogenic gas emissions are projected to change future climates with potentially nontrivial impacts and the impacts of the increased CO_2 concentration are, among others, the greenhouse effect, the acidification of the surface of the ocean and the fertilization of ecosystems. Geologic Sequestration into subsurface rock formations for long-term storage is part of a process frequently referred to as “carbon capture and storage” or CCS. A major strategy for the in situ geological sequestration of CO_2 involves the reaction of CO_2 with Mg-silicates, especially in the form of serpentinites, which are rocks: i) relatively abundant and widely distributed in the Earth’s crust, and ii) thermodynamically convenient for the formation of Mg-carbonates. In nature, carbonate minerals can form during serpentinization or during hydrothermal carbonation and weathering of serpentinites whereas industrial mineral carbonation processes are commonly represented by the reaction of olivine or serpentine with CO_2 to form magnesite + quartz H_2O. Mineral carbonation occurs naturally in the subsurface as a result of fluid–rock interactions within serpentinite, which occur during serpentinization and carbonate alteration. In situ carbonation aims to promote these reactions by injecting CO_2 into porous, subsurface geological formations, such as serpentinite-hosted aquifers.

GEOLOGICAL SETTING

The Southern Apennine chain is a fold-and-thrust belt formed between the upper Oligocene and Quaternary, resulting from the convergence between the African and European plates and the simultaneous rollback of the SE-directed Ionian subduction, which caused the opening of the Tyrrhenian back-arc basin. Relicts of the late Creaceous-Oligocene accretionary wedge, resulting from subduction towards NW of the western Tethys Ocean, occur at the highest structural levels of the Apennine chain (Fig. 1). The accretionary wedge includes the Liguride Complex, consisting of HP/LT metamorphic sequences (the Frido Unit), as well as sequences devoid of a metamorphic overprint (the North-Calabrian Unit). Ophiolitic slices are present both in the Frido Unit and in the North-Calabrian Unit.

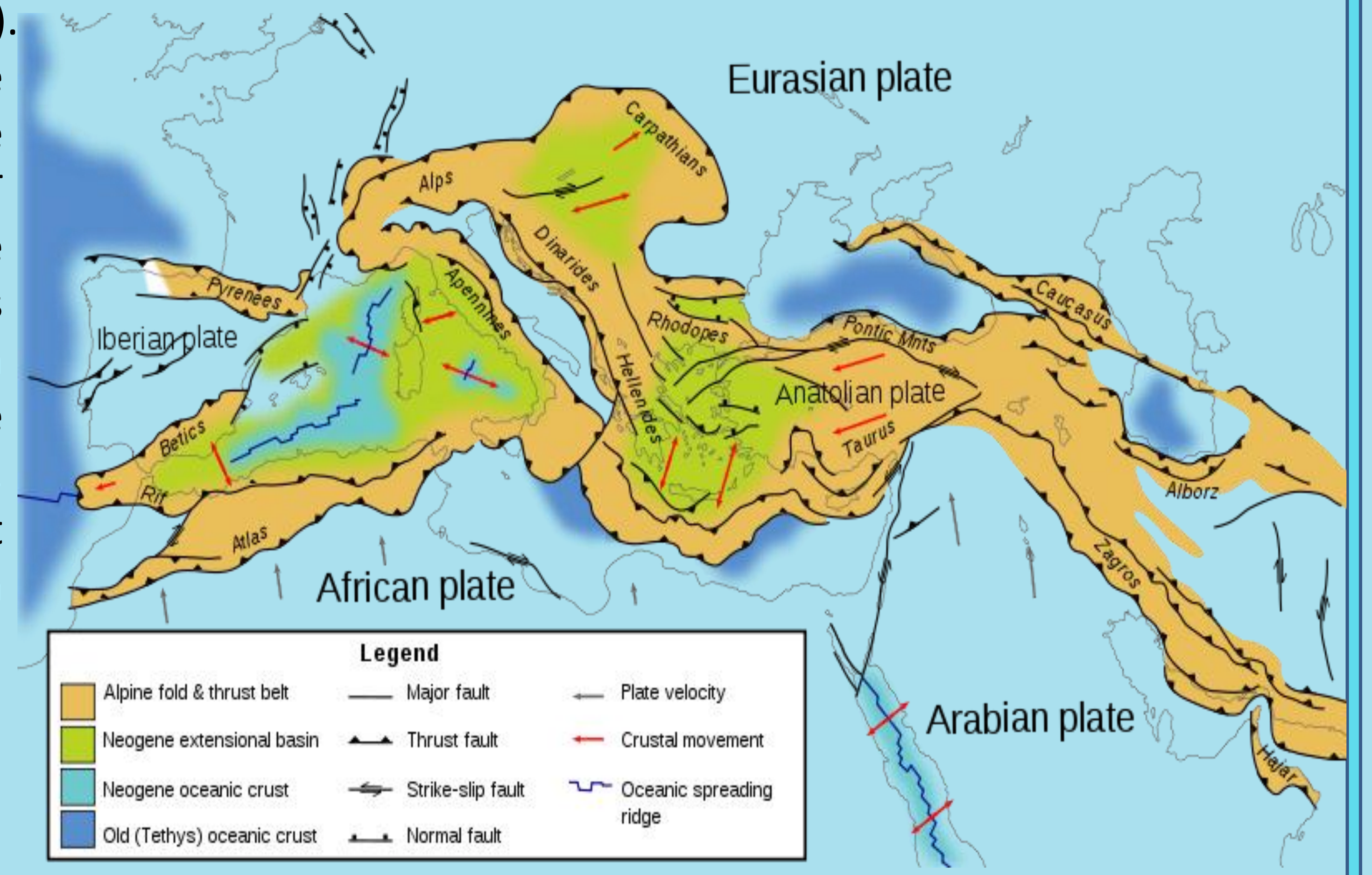


Fig.1 Tectonic map of the Mediterranean area.

STUDY AREA

The ophiolitich rocks studied belong to the Frido Unit consisting of serpentinites, derived from mantle lherzolite and subordinate harzburgite. Metagabbros, metabasalts, and their respective sedimentary cover, showing a very low-grade metamorphic overprint. The Frido Unit serpentinites were collected at Timpa Castello Quarry and Pietrapica Quarry, located at the Calabria-Lucanian border.

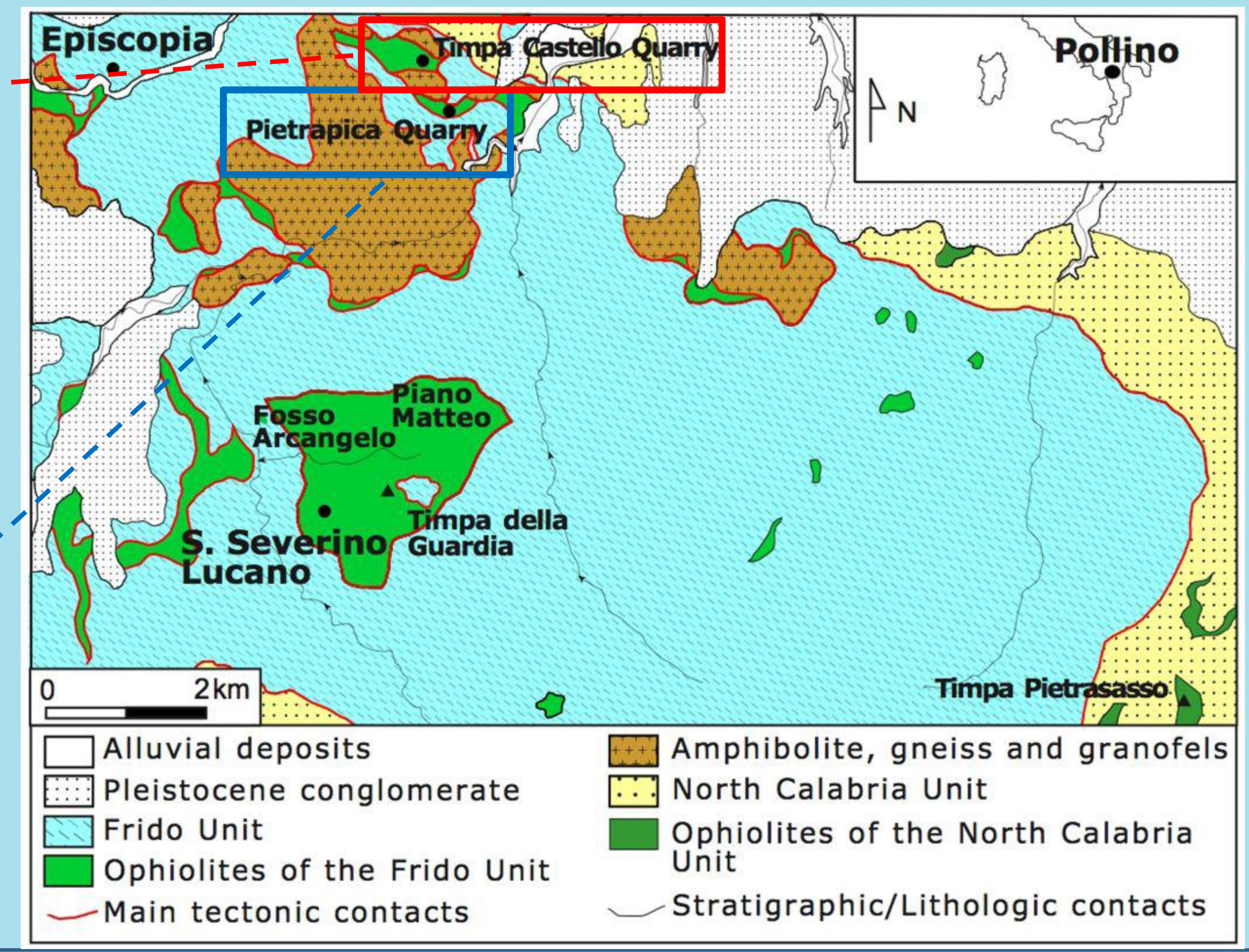


Fig. 2 Simplified geological map of the study area (see text), modified afte.

PETROGRAPHY

The serpentinites studied are distinguished by into in cataclastic and massive. The serpentinites derive from serpentinization of mantle peridotites with porphyroclastic texture. Serpentinization produced a pseudomorphic mesh texture defined by serpentine+magnetite that statically replace olivine crystals (fig.3), and by yellow-brown bastite replacing orthopyroxene (fig.4). Pseudomorphic texture is crosscut by various sets of submillimetric veins mostly filled with serpentine fibers (fig.5). The serpentinites consist of olivine (fig.6), pyroxene (fig.7) and spinel (fig.8), which represent the primary minerals. Secondary minerals are serpentine, chlorite, magnetite, prehnite, and amphibole; accessory minerals are epidote and Fe-hydroxides.

Fig.3 Mesh texture, 1N, 4X.

Fig.4 Bastite replacing orthopyroxene, NX, 2X.

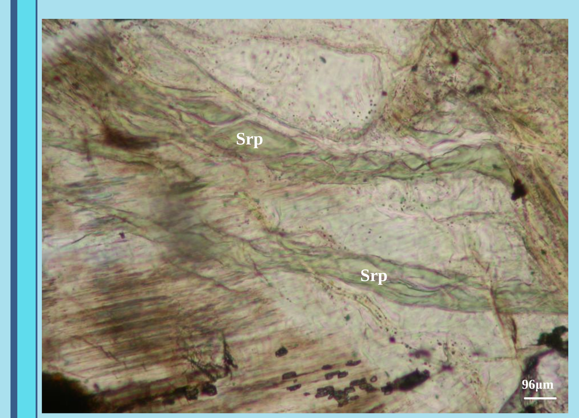


Fig. 5 Vein with serpentine fibers, 1N, 10X.

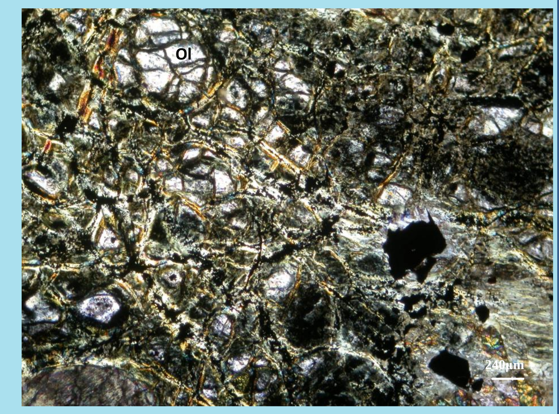


Fig. 6 Mesh texture with olivine crystals, NX, 4X.

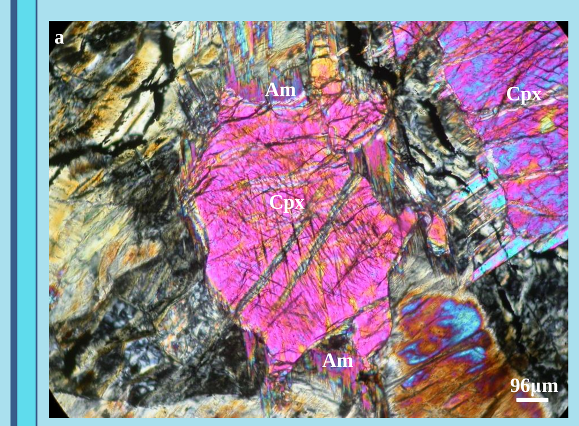


Fig.7 Clinopyroxene armured by tremolite rim, 1N, 10X.

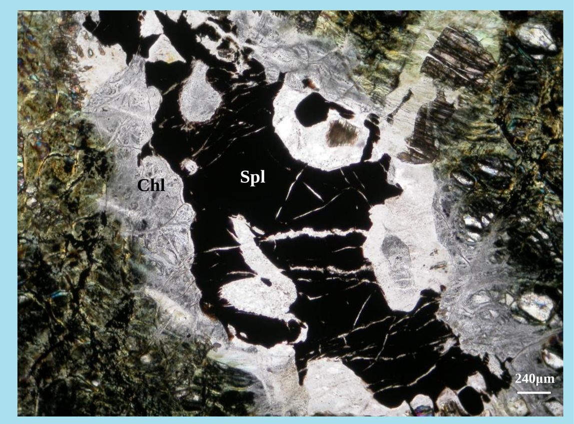
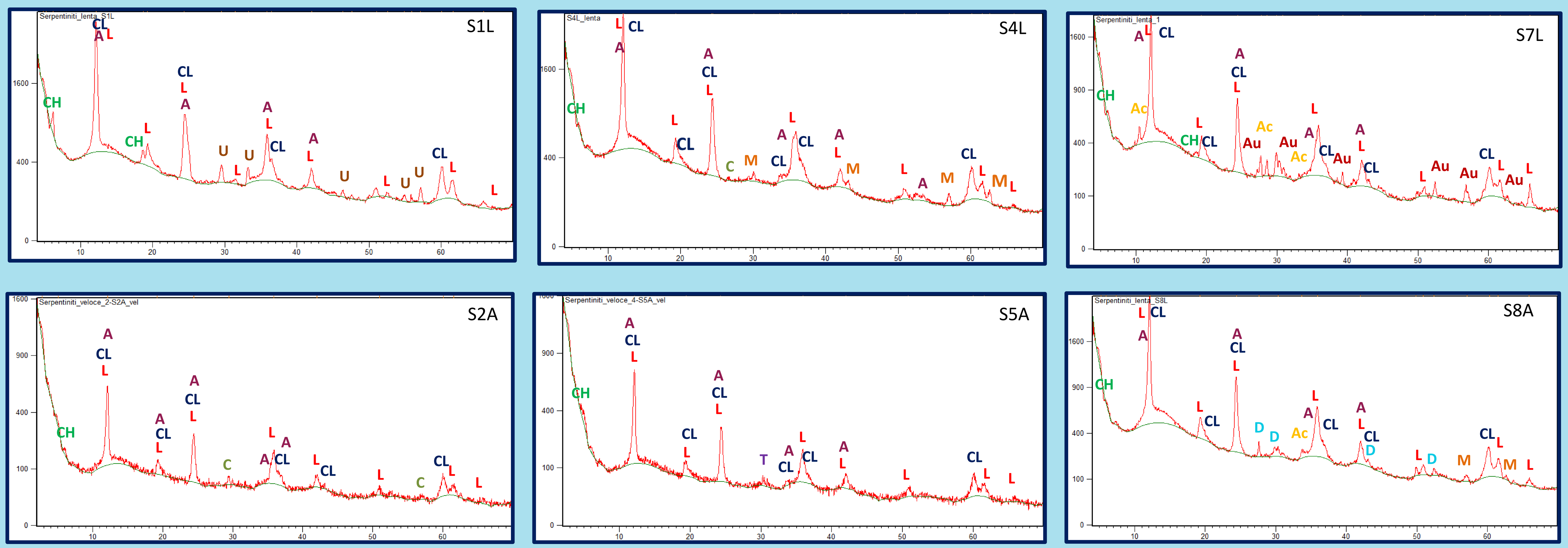


Fig.8 Cr-chlorite corona of Spinel, NX, 2X.

MINERALOGY (XRD analysis)



Semiquantitative XRD analyses were performed on all samples using X-ray diffractometer using CuKα radiation, 40 kV and 40 mA, 4 s per step, and a step scan of 0,01°, 2θ was used. X-ray diffraction shows that the mineralogy of the serpentinites consists of Lizardite, Antigorite,Clinochrysotile, Chlorite chromian, Magnetite, Tremolite, Actinolite, Pyroxene and calcite. In a sample (S1) there is the presence of uvarovite. Uvarovite formation can be considered a Ca-metasomatic process, in which the addition of Ca destabilizes the principal iron host in serpentinite (i.e. magnetite) in favour of uvarovite.

*XRD pattern of serpentinite samples S1L/S2A/S4L/S5A/S7L/S8L Legend: **L** Lizardite; **A** Antigorite; **CL** Clinocrisotyilo; **CH** Chlorite-chromian; **M** Magnetite; **T** Tremolite; **Ac** Actinolite; **D** Diopside; **Au** Augite; **C** Calcite, **U** Uvarovite.*