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Metamorphic evolution of metadolerites from the Frido Unit ophiolites (Southern Apennine-Italy)

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The Southern Apennines chain is a fold-and-thrust belt resulting from the convergence of the African and European plates and simultaneous roll-back of SE-directed Ionian subduction (Upper Oligocene-Quaternary). Ophiolites in the Southern Apennines are related to northwest subduction of the oceanic lithosphere pertaining to the Ligurian sector of the Jurassic western Tethys. The ophiolitic sequences are enclosed within remnants of the Liguride accretionary wedge now incorporated in the Southern Apennine chain and they crop out in the north-eastern slope of the Pollino Ridge (Calabria-Lucania border zone). Mafic and ultramafic rocks, with garnet-bearing felses, amphibolites, gneiss and granitoides occur as tectonic slices within a matrix mainly composed of calcschists and phyllites. Metadolerites occur as dikes cutting through serpentinized peridotites. Metadolerites have different kinds of texture reflecting various degree of crystallinity and strain: porphyritic or aphyric, intersertal/intergranular, blastophitic, cataclastic to mylonitic. In all metadolerites primary plagioclase and clinopyroxene can be observed. The metamorphic mineral assemblage consists of brown amphibole, green amphibole, chlorite, blue amphibole, pumpellyite, prehnite, quartz, epidote, white mica, lawsonite and plagioclase (Pl2 and Pl3). Accessory phases are opaque minerals, Fe-hydroxides and zircon. Metadolerites are cross- cut by veins filled with pumpellyite, chlorite, prehnite, tremolite, plagioclase, white, mica, quartz, lawsonite, epidote and zircon. The veins are straight, a few millimetres in thickness and occur isolated or in closely spaced sets. The vein morphology ranges from planar to sinuous and irregular. On the basis of metamorphic mineral phases three different types of metadolerite can be distinguished: i) rocks with a high content of prehnite crystals in cataclastic–mylonitic bands, exhibiting an intersertal or a blastophitic texture or a mylonitic fabric and in some cases a seriate texture; ii) rocks with brown horneblende showing an intersertal or a blastophitic texture or a partially blastophitic and foliate texture in one specimen; iii) rocks with brown horneblende and blue amphibole with an intersertal or a blastophitic texture. Primary clinopyroxene is replaced by brown and green amphiboles interpreted as being of oceanic origin; brown amphiboles show Mg-hastingsite, edenite, pargasite, Fe-hastingsite, Mg-horneblende and tschermakite compositions, whereas green amphiboles show Mg-hastingsite, hastingsite, edenite, Mg-horneblende, tschermakite and Fe-tschermakite compositions. Other minerals developed in the amphibolite facies conditions are: oligoclase, titanite and apatite. The blue amphiboles have a winchite and barrowisite composition and are interpreted as being originated during the early stages of the orogenic metamorphism, since they rim the oceanic brown and green amphiboles.

The mineral assemblage of orogenic metamorphism is typical of the LT-blueschist facies conditions and consists of glaucophane, Mg-riebekite, lawsonite, phengite, pumpellyite and aegerin-augite. Bulk-rock chemistry of metadolerites suggests that protoliths of the mafic rock have a N-MORB-type affinity. Ca-rich metadolerites are affected by ocean-floor rodingitic alteration, whereas Na-rich metadolerites show a spilitic alteration. The study of metadolerites from Frido Unit show evidence of the entire evolution from their origin in the ocean floor to their emplacement in the accretionary wedge. Textural and mineralogical observations suggest that the metadolerites of the Frido Unit have been affected by both ocean-floor metamorphism in the amphibolite to greenschist facies- and subsequent orogenic metamorphism under relatively HP/LT conditions. The HP/LT orogenic metamorphism reflecting underplating of the ophiolitic suite at the base of the Liguride accretionary wedge during subduction produced mineral assemblages typical of the lawsonite-glaucophane facies. Such polyphase metamorphic evolution has been entirely preserved in the metadolerites probably in response to inhomogeneous deformation within the Apennine accretionary wedge.