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Two Tertiary metamorphic events recognized in metapelites of the Nevado-Filabride Complex (Betic Cordillera, S Spain)

Botao Li and Hans-Joachim Massonne

Institut für Mineralogie und Kristallchemie, University of Stuttgart, Stuttgart, Germany (libotao123@hotmail.com)

The orogenic belt of the Betic Cordillera in southern Spain resulted from the collision of the African plate with the southwestern edge of the Eurasian plate in Alpine times. This belt can be considered as a large nappe stack with the Nevado-Filabride Complex in the eastern Betic Cordillera representing the lowest nappe, in which high-pressure (HP $>$ 10 kbar) rocks such as eclogites occur. We have studied two metapelites from the Ragua (former Veleta) unit, which is the lowest unit of the Nevado-Filabride Complex. These rocks were sampled at Cerro de los Machos (sample 23085) and c. 3 km east of this locality at the Laguna de la Caldera (sample 23098) and contain quartz, potassic white-mica, paragonite, chlorite, garnet, biotite, tourmaline, epidote, rutile, ilmenite, apatite, zircon and monazite and titanite (23085) or calcite and albite (23098). Garnet in both rocks is similarly zoned. An inclusion-rich core shows a prograde metamorphic zonation with high and low Mn contents in the center (e.g. for 23085: $Alm_{64.5}Grs_{27}Py_{2.5}Sps_{6}$) and at the rim ($Alm_{84}Grs_{8}Py_{6}Sps_{2}$), respectively, of the core domain. After corrosion of this domain a garnet mantle formed with an inner zone being again relatively rich in Mn and an outermost rim being poor in Mn. This mantle is significantly richer in Mg and poorer in Ca compared to the core domain. Potassic white-mica in the samples also shows a considerable compositional spread (Si = 3.05-3.20 in 23085 and 3.13-3.33 in 23098) with the highest Si contents in the core of potassic white-mica grains.

To elucidate the metamorphic evolution of the rocks we calculated various P-T pseudosections for different H_2O-CO_2 contents and Fe^{3+}/Fe^{2+} ratios with PERPLE_X. On the basis of the compositions of the garnet inner core and the highest Si content in potassic white mica contrasting peak pressures at c. 535˚C resulted for the rocks (23085: 12.8 kbar, 23098: 18.3 kbar). A subsequent pressure release to about 8 (23085) or 5 kbar (23098) at slightly enhanced temperatures followed. A second P-T loop was derived from the garnet mantle compositions reaching peak temperatures close to 600˚C, supported by Zr-in-rutile thermometry, at pressures of about 10 kbar.

Nearly 100 electron microprobe analyses of small relics of corroded monazite yielded ages between 50 and 11 Ma. Y_2O_3 contents in monazite were between 0 and 1 wt.%. Monazite relics included in the garnet mantle gave an average age of 24.2 $\pm$ 3.2 Ma. We suppose that the peak pressures in the HP range of the early metamorphic loop were attained already in Eocene times, whereas the rocks experienced peak temperatures in the Late Oligocene. The exhumation of the rocks in the Eocene might have happened in an exhumation channel being located between the colliding continental plates. The material in the exhumation channel consisted mainly of previously subducted oceanic crust (eclogite) and sediments deposited at the margin of the plates. The Late Oligocene event is related to nappe stacking forming the Betic Cordillera.