P-T path determination using phase equilibria modelling with multiple fractionation of garnet in a metapelite

Carlos Iván Lembo Wuest[1,*], Samanta Serra-Varela[2], Sebastián O. Verdecchia[1,3], Juan A. Murra[1,3], Manuela E. Benítez[4,5] and Gladis Palacio Baderramo[6]

[1]Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET), Centro de investigaciones en Ciencias de la Tierra (CICTERRA), Av. Vélez Sarsfield 1611, X5016CGA Córdoba, Argentina.
[2]Universidad Nacional de Río Negro, Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET), Instituto de Investigaciones en Paleobiología y Geología. Av. Roca 1242, 8332, General Roca, Río Negro, Argentina.
[3]Universidad Nacional de Córdoba. Facultad de Ciencias Exactas, Físicas y Naturales. Av. Vélez Sarsfield 1611, X5016CGA. Córdoba, Argentina
[4]Instituto de Recursos Minerales (INREMI), La Plata, provincia de Buenos Aires, Argentina
[5]Comisión de Investigaciones Científicas de la provincia de Buenos Aires (CICPBA)
[6]Centro de Investigación de la Geosfera y Biosfera (Consejo Nacional de Investigaciones Científicas y Tecnológicas, CONICET), Gabinete de Mineralogía y Petrología, Facultad de Ciencias Exactas Físicas y Naturales. Universidad Nacional de San Juan (San Juan – Argentina).
*E-mail: civanlw@gmail.com

Zoned garnets are considered useful to determine prograde metamorphic evolution, in which a fractionation of chemical components from whole-rock composition occurs. Thus, effective bulk composition (EBC) should change while garnet is growing to remove the essential components used for its nucleation. Therefore, a step-by-step estimate of the equilibrium volume is necessary to reconstruct the *P-T* path toward the metamorphic peak. In this work, we analyze a metamorphic *P-T* path for a garnet mica-schist from Sierra El Gigante (Argentina) using multiple fractionations of garnet in conjunction with *P-T* pseudosections and compositional isopleths based on chemical mineral analysis.

Garnet zoning is characterized by a core with Sps_{21}-Grs_{23}-Alm_{54}-Prp_4 that progressively changes toward a Sps_6-Grs_{22}-Alm_{65}-Prp_6 rim. The chemical fractionation was conducted using Theriak-Domino software and successive new bulk compositions were obtained. Five stages of garnet fractionation from core to rim were defined from the compositional profile of garnet, for each of which the EBC was calculated. For each stage, *P-T* conditions were estimated from Sps (X_{Mn}), Alm (X_{Fe}), and Sps (X_{Mn}) isopleths. Thus, *P-T* condition for the initial nucleation of garnet was calculated at 545° C and 7.2 kbars, whereas the rim (*P-T* peak) is constrained at 595° C and 9.5 kbar, inside of stability *P-T* field of plagioclase - garnet - muscovite - paragonite - biotite - albite - quartz - rutile.

The last garnet fractionation after the estimation of the *P-T* peak was performed for retrograde stage analysis. In this step, a simplified system without Ca and Mn was selected because the matrix is composed of albite, muscovite, chlorite, biotite, and rutile. Thus, 390° C and 6 kbars were calculated from Si (p.f.u.) of muscovite and Mg/(Mg + Fe) of chlorite.

The results suggest that the metapelites from Sierra El Gigante evolved over a high *P/T* gradient in the prograde segment.