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Origin and significance of phosphate minerals in the Central Iberian Zone (Spain and Portugal): implications for the behaviour of P during the Variscan magmatism

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Phosphates are widespread accessory minerals in pegmatites from the Central Iberian Zone (CIZ) (Spain and Portugal); in some of them forming part of the main paragenesis. In addition, phosphates may occur as accessory phases in granitic rocks and may be also abundant in some quartz veins. The CIZ represents the innermost part of the Iberian Variscan Belt in which large volumes of granitic rocks occur. Variscan granites can be divided into two main groups: (1) pre- to syntectonic, peraluminous, locally two-mica leucogranites; and (2) undeformed granitoids, mainly subporphyritic, K-feldspar-rich granodiorites. These granitic rocks intruded Precambrian and Cambrian metasedimets, with low to high degrees of metamorphism. Gneisses and migmatites are also common in some areas.

Pegmatites as Pinilla de Fermoselle, Cañada, Mangualde, Nª Srª Assunçao, and Pereña, epitomize the rocks with typical phosphate associations in the CIZ. Likewise, Folgosinho, Bendada, El Trasquilón, and Valdeflores represent occurrences of phosphate-bearing quartz veins; and phosphates as accessory phases may be found in the Alburquerque, Jálama, Seixoso and Argemela batholits. Though numerous secondary phosphates occur in these rocks, the diversity of primary phosphates is, nonetheless, quite limited. Minerals of the tryphilite-lithiophilite series are the most common primary phosphates in evolved pegmatites, whereas graftonite, wagnerite, and triplite-zwieselite are more common in lithologies with a lower evolution degree. Amblygonite-montebrasite series are also common in both pegmatites and quartz veins.

The Fe/(Fe+Mn) ratio in phosphates has been used frequently to establish the degree of fractionation of its hosting rock, this ratio decreasing as the degree of evolution increases. In the CIZ, this ratio seems to reflect well such evolution, with the exception of the Cañada pegmatite, where it is better reflected by the Fe/(Fe+Mg) ratio. It is not rare that the Fe-Mn phosphates are the only Fe-Mn-(Mg)-bearing phases in these rocks, mainly in the pegmatites and quartz-rich dykes. However, it is also relatively common that biotite, tourmaline and/or garnet occur together with them. The occurrence of other Fe-Mg-Mn minerals with the phosphates seems not to have influenced the chemistry of phosphates in relation to the Fe/(Fe+Mn) ratio, opposite to what is observed for some other phosphates occurrences in the world.

In the northern part of the CIZ most of the phosphate-bearing rocks are presumably related to pre- to synkinematic anatectic leucogranites, whereas in the southern regions phosphate-bearing lithologies seem to be mainly related to late- to post-tectonic granitic rocks. This may be indicative of a significant mobilization of phosphorous during the Variscan magmatism in the CIZ. Phosphorus has a marked influence on the evolution of silicate melts, as it significantly alters the chemical and physical properties of the magmas. The crystallization of plagioclase in the parental granite would cause a decrease in the Ca/P ratio in the melt. Hence apatite precipitation would be limited and P would behave as an incompatible element. As a result, the P content in the residual melt would increase with fractionation and, finally, it could be discharged during the late stages of crystallization by the formation of phosphates.