

Vesuvianite as a key tool for the reconstruction of skarn formation conditions: An example from the Sauce Chico Complex, Argentina

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ABSTRACT

In the Sauce Chico Complex (Neoproterozoic–middle Cambrian age; Ventania System, Argentina), polymetamorphosed carbonate xenoliths known as the Loma Marcelo skarn are hosted in an Ediacaran peraluminous granite. The skarn has three types of vesuvianite, namely a, b, and c, with different colors, habits, and/or mineral assemblages. They were studied through petrographic microscopy, electron microprobe, inductively coupled mass and atomic emission spectrometry, Raman and Mössbauer spectroscopy, X-ray diffraction (powder and single-crystal), and fluid inclusion and stable isotope analyses. The average composition of the Loma Marcelo skarn vesuvianite is $X_{Ca_{19.00}}Y_{(Al_{9.57}Fe_{1.29}^{2+}Fe_{0.50}^{3+}Mg_{1.17}Ti_{0.48}Mn_{0.04}^{2+})_{\Sigma 13.05}}Z_{(Si_{18}O_{68})}W_{(OH_{5.79}F_{3.03}Cl_{2.08}O_{0.90})_{\Sigma 10.00}}$ and corresponds to vesuvianite *sensu stricto*. Negligible amounts of ^{23}Na and ^{10}B were detected. Only Zn, Sr, Ce, La, and Sn are in concentrations >50 ppm. Through single-crystal XRD, the crystal structures of vesuvianite types a and b were refined in the $P4/nmc$ space group (domains with $P4/n$ symmetry are also present). Type c vesuvianite could not be satisfactorily refined; however, a $P4/n$ symmetry is suspected. By comparing the Loma Marcelo skarn vesuvianite cell parameters with those of other vesuvianites worldwide, it becomes clear that symmetry does not influence these parameters. Based on Raman, single-crystal XRD data, and structural and chemical characteristics, formation temperatures of 550 °C (type b), 450 °C (type a), and 300–400 °C (type c) were estimated. The $\delta^{18}O_{H_2O}$ values of ca. +11.9‰ calculated for these temperatures from $\delta^{18}O$ values determined on vesuvianite concentrates and vesuvianite–water fractionation factors are compatible with a peraluminous granitic source. The Loma Marcelo skarn vesuvianite appears to reflect a retrograde process related to the crystallization of the Ediacaran granite hosting the metasomatized xenoliths. During a subsequent protracted Permian tectono-metamorphic event, biphasic secondary fluid inclusions were trapped at ca. 270–339 °C (ca. 250 MPa) from low salinity metamorphic fluids. Stable isotope determinations of H and O on vesuvianite concentrates indicate that the interaction with magmatic and metamorphic aqueous fluids promoted modifications in the $^2H/^1H$ ratios of the hydroxyl groups from the *W* sites, whereas the $^{18}O/^{16}O$ ratios of the silicate groups were not substantially modified. Notably, the vesuvianite structure is highly stable, remaining unchanged after formation. This stability suggests that vesuvianite-group minerals could serve as a reliable XRD-based thermometer.

Keywords: Loma Marcelo skarn, vesuvianite, chemistry, spectroscopy, X-ray diffraction, fluid inclusions, stable isotopes