American Mineralogist, Volume 103, pages 629–644, 2018

Ni-serpentine nanoflakes in the garnierite ore from Campello Monti (Strona Valley, Italy): Népouite with some pecoraite outlines and the processing of Ni-containing ore bodies

Gian Carlo Capitani[1,*] and Gennaro Ventruti[2]

[1]Dipartimento di Scienze dell'Ambiente e di Scienze della Terra, Università degli Studi di Milano-Bicocca, I-20126 Milano, Italy
[2]Dipartimento di Scienze della Terra e Geoambientali, Università di Bari, I-70125 Bari, Italy

Abstract

The garnierite ore at Campello Monti occurs as dark green colloform concretions covering surfaces, fractures, and filling veins in harzburgite rocks. The representative composition $(Ni_{2.45}Mg_{0.14}Cu_{0.12}Co_{0.05})_{\Sigma 2.76}Si_{2.10}O_5(OH)_4$ is consistent with a 7 Å phase, namely pecoraite or népouite. Relevant chemical features are an exceptionally high Ni/Mg ratio, a significant level of Cu substituting for Ni, and a low content of S, possibly in tetrahedral sites.

Olivine and orthopyroxene in the harzburgite host rock are only partially serpentinized, do not contain detectable Ni, and are almost iron free. The green coating probably originated from groundwater solutions that leached nearby weathered peridotites and sulfide ores, and deposited less-mobile elements along fractures and voids of the host peridotite, just outside their provenance area.

Bulk techniques such as X-ray powder diffraction and infrared spectroscopy do not confidently distinguish between népouite and pecoraite, although the comparison with synthetic, implicitly pure polymorphs indicates népouite as the best matching phase. On the other hand, HRTEM clearly shows that garnierite is mostly constituted by plumose aggregates made of curved crystals with frayed tips, a few nanometers thick along the stacks and a few tens of nanometers long (nanoflakes). All known lizardite stacking sequences, namely 1*T*, $2H_1$, and $2H_2$, have been locally observed, even though most crystals show stacking disorder.

The recorded nanostructure suggests possible explanations for the recurrent anomalies (low oxide totals, high $^{IV}T/^{VI}M$ cation ratios, etc.) found in EMP analyses of garnierites. The small grain size, the high density of defects, and the structural arrangement actually intermediate between lizardite and chrysotile probably explain the ambiguities that occurred during the characterization with bulk techniques. The results obtained in this study may have important implications for ore processing methods.

Keywords: Garnierite, népouite, nanoparticles, transmission electron microscopy