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Agricultural geochemistry in viticulture: an example of Cu accumulation and geochemical fractionation in Mediterranean calcareous soils (Nemea region, Greece)

Efstratios Kelepertzis¹, Fotini Botsou², Carla Patinha³, Ariadne Argyraki¹, Ioannis Massas⁴

¹ Laboratory of Economic Geology and Geochemistry, Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Panepistimiopolis, Zographou, 15784, Athens, Greece

² Laboratory of Environmental Chemistry, Department of Chemistry, National and Kapodistrian University of Athens, Panepistimiopolis, Zographou, 15784, Athens, Greece

³ GEOBIOTEC- Department of Geoscience, University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal

⁴ Laboratory of Soil Science and Agricultural Chemistry, Department of Natural Resources and Agricultural Engineering, Agricultural University of Athens, 75 Iera Odos St., 11855, Athens, Greece

Corresponding author: Efstratios Kelepertzis (kelepert@geol.uoa.gr)

Abstract

The Nemea region has been devoted to viticulture from historic times, and currently, is one of the most important wine-producing areas in Greece. In this study we report the extent of Cu and other element (As, Cd, Co, Cr, Mn, Ni, Pb, and Zn) enrichment, their geochemical partitioning into the soil components (evaluated by a seven-step sequential extraction procedure) and the plant availability of Cu (defined as the diethylene triamine pentaacetic acid, DTPA –extracted Cu). Major soil properties were also determined. Total Cu contents in the Nemea topsoil were in the range 33.1–291 mg kg⁻¹. Enrichment Factors (EF), calculated against uncultivated soils from the neighboring Argos region, showed that the Nemea topsoil was significantly enriched with Cu (median EF 5.9) and in a limited number of samples moderately enriched (median EFs: 2–5) with P, As, Cd and Mn. On average, 20% of total Cu was readily available for plant uptake. Application of principal component analysis (PCA) showed that natural Cu present in Nemea soil was principally associated with the residual and oxidizable fractions. On the other hand, anthropogenic related Cu was linked to acid soluble and reducible geochemical phases, exhibiting a strong affinity with the plant available Cu. Nickel and Cr were principally found in the residual fraction, supporting their origin from ophiolitic rocks; Manganese and Co were mostly associated with Mn oxides, Cd was found in labile fractions, whereas As, Pb and Zn were bound, more or less, to reducible and oxidizable substrates. Copper and P were the only elements that were found to decline at the 50 cm soil depth. Despite the decline with depth, Cu contents did not reach background levels. We did not find differences in Cu availability and partitioning between the surface and deep soil samples, inferring that Cu migrated to the soil profile by tillage practices. Finally, the comparison of the

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