New insights on highly siderophile and chalcophile element behaviour in abyssal-type and supra-subduction zone mantle sections of the New Caledonia ophiolite

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The New Caledonia Ophiolite hosts one of the largest obducted mantle sections worldwide. The mantle section is mostly composed of harzburgite and dunite, however, minor serpentinized spinel and plagioclase lherzolites also occur in the northern part of the island. The major and trace element and Sr-Nd-Pb isotopic composition of the harzburgites can be reconciled with a complex history of multiple melting episodes followed by localized overprint by fluids and/or hydrous melts in a supra-subduction zone setting, while the lherzolites are similar to abyssal-type peridotites (Secchiari, 2016).

As the harzburgites were not altered by low-temperature processes and apparently reflect the transition from ‘normal’ oceanic lithospheric mantle to supra-subduction zone mantle, this rock association offers the unique opportunity to study the behaviour of highly siderophile (HSE: Os, Ir, Ru, Rh, Pt, Pd, Au, Re) and chalcophile elements (S, Se, Te) in mantle from these different geodynamic settings.

Harzburgites can be grouped in two different sub-types. Type A harzburgites (+9.3 ≤ εNd ≤ +13.3) show subchondritic $^{187}$Os/$^{188}$Os (0.1203-0.1254), coupled with low Os concentrations (0.55-1.51 ppb) and low Re/Os. These harzburgites display fractionated, Os-Ir–Ru–enriched patterns, with increasing depletion towards Au and Re and a pronounced positive spike of Pt. S, Se, and Te are often at, or below, the detection limit. These features can be ascribed to sulphide exhaustion after high melting degrees and Os-Ir-Ru and Pt-Ir alloy stabilization.

Type B harzburgites (+0.8 ≤ εNd ≤ +4.0) show chondritic to suprachondritic measured $^{187}$Os/$^{188}$Os (0.1273-0.1524), very low Os and Ir concentrations (0.003-0.277 ppb) and suprachondritic and highly variable $^{187}$Re/$^{188}$Os (2-30). HSE have “melt-like” patterns with strongly fractionated Os-Ir-Ru (OsN/RuN=0.02-0.46) coupled with strongly negative Pt anomalies and positive Au spikes. S, Se, Te are close to or below the detection limit. Such element patterns have never been identified in mantle peridotites before. We interpret these features as resulting from localized modification of type-A harzburgites after interaction with subduction-related oxidizing fluids or S-undersaturated hydrous melts, which caused the breakdown and dissolution of sulphides and alloys, preferentially removing Os, Ir, Pt and elements hosted by mantle sulphides.

The present work indicates that some of the features displayed by arc lavas such as positive Pt spikes may be complementary to the composition of sub-arc mantle sources.