Magmatic volatile fluxes through two subduction zones:
The Canadian Cascades & the Lesser Antilles

Overview: Volatile elements are transferred from the Earth's mantle to the atmosphere and arc volcanoes represent their most efficient transfer mechanism. Degassing at volcanoes and hydrothermal activity are the link between the deep Earth and the surface. Indeed, at active volcanoes (e.g., La Soufrière, Guadeloupe), gas and heat transfer from deep magma reservoirs to shallow aquifers will sustain hydrothermal activity and can lead to pressurisation and eventual explosive eruptions. While variations in the concentrations of these magmatic gases can be indicative of changes in the shallow volcanic plumbing system, hydrothermal systems will interact with the volcanic gases making it difficult to constrain the temporal evolution of the magmatic systems. Furthermore, at dormant volcanic systems (e.g., Mt. Meager, B.C.) with sporadic hydrothermal activity and little or no degassing, the ability to detect potential eruption precursors is severely restricted. Forensic geochemical techniques such as the study of melt inclusions (MIs) trapped within mineral phases are thus required to constrain the pre-eruptive parental magma composition as well as the potential volatile budgets upon eruption; MI studies can potentially enable localisation of magmatic storage systems.

Key knowledge gaps: Recent studies have investigated the mantle sources of basalts found in the Canadian segment of the Cascade arc (the Garibaldi Volcanic Belt, GVB), however, nothing is known about the shallow to mid-crustal plumbing systems of these volcanoes nor the previous flux of magmatic volatiles through the GVB arc. Similarly, very few volatile abundance studies have been performed in the parental magmas of Lesser Antilles (LA) volcanoes. Fumarolic activity is present in various active volcanoes of the LA, especially at La Soufrière where degassing activity has gradually intensified since 1992. However, the physicochemical dynamics of hydrothermal systems and their effect on degassing are still poorly understood while the volatiles fluxes through LA as a whole are also unknown.

Approach and major outcomes: We plan to study MIs, especially their major and volatile elements (e.g., H_2O, CO_2, S), from various volcanoes in both the GVB and LA arcs in order to characterise (i) the volatile concentrations and the P, T, fO_2 conditions of the primary magmatic sources, (ii) the depth of storage zones, (iii) the petrogenetic and degassing processes and (iv) the volatile fluxes. Moreover, we plan to place constraints on the volatile fluxes by an extensive study of fumarole gas geochemistry (H_2O, CO_2, H_2S, SO_2) using a MultiGAS system on volcanoes from LA and/or via the analysis of streams around both GVB and LA volcanoes. Stream geochemistry studies will help characterise the interaction between magmatic gases and the associated hydrothermal systems. Overall, this multi-disciplinary project aims to develop the first compressive magmatic degassing history of the parental basalts from both the GVB and LA arcs.