ABSTRACT

The Volcanic Geology of the pre-Soufrière rocks on St. Vincent, West Indies

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St. Vincent is located between latitude 13° and 13°30' N and longitude 61° and 61°30' S within the Lesser Antilles Island Arc, a region of active volcanism caused by subduction of the North American and/or South American Plate beneath the Caribbean Plate. Volcanism on St. Vincent migrated from the south (~3 Ma) to the north (<700 ka) of the island and resulted in the formation of four distinct volcanic centres (South-East Volcanics, Grand Bonhomme, Morne Garu and Soufrière). The northward migration in volcanism was not systematic and activity within and between individual centres overlapped. Despite the overall trend of northward migration in the development of large stratovolcanoes, monogenetic volcanism has been a feature of the island's evolution. Late stage monogenetic spatter cones are most common in the southeast but also occur in other areas on the island.

Pre-Soufrière volcanic centres all appear to have evolved in a similar manner. Early eruptive activity was effusive and produced a substructure of basaltic lava flows. Effusive activity then alternated with periods of explosive eruptions, which produced large strato-cones. This was followed by a dominantly explosive phase, which produced voluminous pyroclastic deposits and collapse features. Eruptive activity culminated with the emplacement of summit domes and plugs.

The most primitive rocks on St. Vincent are the olivine microphyric High-MgO basalts. These rocks contain forsteritic olivine, show no evidence of crystal accumulation and have high *mg*-numbers (>70), high Ni (>240 ppm), Cr (>700 ppm), low FeO*/MgO (<1) and low La/Yb_N ratios (La/Yb_N = 1.16-1.95). Calculated Fe^{2+}/Mg partition coefficients (K_D) for these rocks indicated that they may have been in equilibrium with mantle peridotite at pressures of > 20 kbar and depths of ~60 km. Ca/Na values for plagioclase phenocrysts suggest that crystallisation may have occurred under hydrous conditions with a wide range in melt H_2O content.

Major and trace element contents in pre-Soufrière rocks indicate a role for magma mixing and crystal fractionation with evolutionary paths being complicated by crustal assimilation. Differentiation progressed with initial crystallisation of olivine and clinopyroxene with plagioclase being added later (~ 10 % MgO). Trace element patterns suggest that the mantle source of southern St. Vincent magmas may have been affected by higher degrees of melting relative to MORB and are no more depleted than the source of N-MORB. The magmas originated in a mantle source region, which was not depleted but was modified by addition of a subduction component released as fluid from the descending slab and containing contributions from both altered mafic crust and sediments.

The geochemistry of the Pre-Soufriere magmas is similar to those of the active Soufriere volcano located in the north of the island. However, the Pre-Soufriere rocks exhibit a wider range in compositions and have a greater abundance

of rocks with high MgO content. The genesis and evolution of the volcanic centres that they erupted these magma are also similar and suggest that volcanism on St. Vincent has varied little since its inception in the south-east of the island over three million years ago.

Keywords: St. Vincent; geology; geochemistry; island arc volcanism, High MgO basalts.