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Hydrothermal systems of andesitic volcanoes: a window on shallow depth magmatic activity – mineralogical and geochemical insights

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La Soufrière volcano (Guadeloupe) is characterized by a well-developed active hydrothermal system. That has been a major forcing agent for phreatic eruptions (6 in the last 500 yrs) or in promoting partial edifice-collapses (10 events in the last 15 000 yrs) that emplaced debris-avalanches deposits (DAD). We have performed a detailed mineralogical, trace element and U-Th isotopes study (XRD, MEB-EDS, Elemental and MC ICP-MS) of material from hydrothermally altered DAD blocks from 5 major units dated at 45000, 11500, 7700 and 3100 BP in order to characterize the thermodynamics of the system and date alteration events. The main parageneses observed consist of sulfates, silica polymorphs, clay minerals, sulfides and sulfur. The bulk geochemistry of altered DAD blocks shows three major signatures: (1) a pattern of LREE enrichment and strong HREE depletion from clay minerals, (2) a pattern of complete REE depletion from abundant gypsum highly REE depleted, (3) a source rock REE pattern but with evidence of redistribution of chemical elements at a scale $< cm^3$. DAD samples show a large range of U (0.2 to 2.1 ppm) and Th (0.7 to 11 ppm) concentrations, although the unaltered source material displays a narrow U-Th composition range. Preliminary isotopic results demonstrate that U series disequilibrium provides a tool to date the hydrothermal material in a DAD. Moreover this work shows that time constants for the development of hydrothermal alteration processes can be estimated. This has important implications for improving hazard assessment from potentially unstable andesitic volcanoes hosting an active hydrothermal system.