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Chemical weathering of basaltic lava-flow since 300 kyr ago (La Réunion Island ,France)

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Spheroidal weathering (also named corestone-shell systems hereafter called CSC) is a common form of chemical weathering affecting many types of rocks. Here we combine mineralogical observations, geochemistry of major and trace elements to Sr isotopes and U-series as an attempt to constrain the rate of spheroidal weathering of a basaltic flow dated at 292 $\pm$13 ka from Piton de la Fournaise volcano (Réunion Island). Three zones can be characterized : corestones, grey and red shells. Our results show that weathering is increasing from the core to the red shells and is characterized by a loss of alkali elements and Si while Fe, Al and Ti contents remain constant. Total chemical weathering rates, calculated over 292 ka, are two orders of magnitude lower than present-day estimations from streamwater solute fluxes. Our results show that Sr is exported on a time scale of 1 rather than 300 ka. The extrapolation of this behaviour to all mobile elements allows to recalculate a total chemical weathering rate of 270 t/km2/yr, in the range of the present day estimations. Zr and Th appear as the most immobile elements. Uranium, on the opposite, is shown to be depleted in the cores and the grey shells but enriched in the red shells, probably adsorbed on Fe oxydes and halloysite. A U-transport model is used to estimate the weathering age of samples from the core and the grey and red shells. The process of U remobilization occurs on a timescale of ca 290 ka, i.e. the deposition age of the lava flow. The calculated weathering ages increase from the core to the red shells. Weathering rates are 5.5 $\pm$ 0.7 m/Ma for the grey shells and 1.4 $\pm$ 0.2 m/Ma for the red shells, with an average value of 2.9 $\pm$ 0.3 m/Ma. Finally, this result, compared with denudation rates of 3.5 $\pm$ 1.7 m/Ma estimated in the same area strenghthens our conclusion regarding a stable, steady state, geomorphological evolution of the site.