
Rapid magma differentiation, gas accumulation and the size of the magma chamber beneath Hekla volcano, Iceland, from ^{238}U -series disequilibria.

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Résumé

Eruptions at Hekla volcano in Iceland start explosively with production of differentially evolved magma related to the length of the foregoing quiescence period, and end with basaltic andesite lava of uniform composition. The basaltic andesite is formed by fractional crystallisation from a deeper-seated basalt source in a steady-state manner. Measured Ra-Th radioactive disequilibrium, in the ^{238}U decay chain reveals a decrease from a 14% excess of ^{226}Ra over ^{230}Th . The decrease in ^{226}Ra excess to 5% in the basaltic andesite of Hekla is shown to be controlled by plagioclase fractionation alone. Therefore, the magma differentiation time from basalt to intermediate magma beneath Mt. Hekla is significantly shorter than three centuries, the time needed to detect significant ^{226}Ra -decay. Given the steady-state production of basaltic andesite magma and the estimated magma production rate, the volume of the basaltic andesite magma accumulation zone/reservoir/magma chamber can be estimated as less than 2 km³. Volcanoes erupting explosively are fed by magma temporarily stored in the crust at a depth that dictates the volatile solubility of the magma and thus the presence and the nature of a gas phase. External gas phase, additionally, may accumulate in a hermetic magma chamber increasing the internal pressure, ultimately leading to an overpressure and an eruption. Gas accumulation is hard to detect but the decay of ^{226}Ra produces ^{222}Rn that will be stored together with the available major gas species, and rapidly decay to ^{210}Pb . Such radon accumulation thus will lead to excess ^{210}Pb over the grandparent ^{226}Ra in the magma accumulating the gas phase. Eruptions at Hekla volcano start explosively producing tephra before an effusive lava forming phase. The tephra of the five latest eruptions of Hekla (1947 to 2000) has either an excess of ^{210}Pb over ^{226}Ra or are in radioactive equilibrium, as are all the lava flows. Since 1947 CE the volume of erupted tephra decline regularly, a trend that correlates with a reduction in radon flux from a deep-seated basalt source into the basaltic andesite magma chamber beneath Hekla. A renewal of the basalt source seems to be needed for the next eruption at Hekla volcano.

Mots-Clés: Ra, ^{210}Pb , Hekla volcano, radioactive disequilibrium, ^{238}U series

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