5.4.P10

Sr isotope zoning in feldspars at Laacher See Volcano, Germany

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Laacher See Volcano belongs to the Eifel quaternary volcanic province (Germany). The phonolitic pyroclastic deposit has been shown to represent the inverted content of a layered magma chamber erupted in a short time [1]. The deposit is increasingly differentiated and crystal poor towards its lowest part, which is inferred to represent the roof of the magma chamber. The $^{87}Sr/^{86}Sr$ ratio varies between 0.7048 and 0.7075 in the Laacher See pumice (groundmass). Mingling with a more mafic magma during eruption is evidenced by hybrid rocks at the top of the deposit, with $^{87}Sr/^{86}Sr$ = 0.7043. Mineral separates show a more limited range in $^{87}Sr/^{86}Sr$ and often lower values than the whole rock and groundmass (0.7047 to 0.7051). From major and minor element zoning patterns in Sanidine, various growth environment have been inferred including the hot, convecting, main magma body, as well as a cooler more differentiated environnment at the margins of the magma chamber [2]. Ba in plagioclase show a peak just before the onset of sanidine crystallisation, which allow us to identify pre-sanidine and post-sanidine plagioclase crystals. We analyse in situ Sr isotopes in sanidine and plagioclases using microdrilling or single grain dissolution and thermal ionisation mass spectrometry.

$^{87}Sr/^{86}Sr$ in microdrilled feldspar zones or single grains range from 0.7046 to 0.7066. The lowest values are found in pre-sanidine plagioclase crystals, the highest in low Sr sanidine from the most differentiated samples, which were inferred to have grown at the magma chamber margin. However, radiogenic cores also exists in some pre-sanidine plagiolases (0.7064) and in sanidine from the main magma body (0.7053). Most of these sanidines have intermediate $^{87}Sr/^{86}Sr$ between 0.7048 and 0.7049, whereas one sanidine intergrown with a plagioclase is between 0.7047 and 0.7048. However no clear correlation is observed between $^{87}Sr/^{86}Sr$ and stratigraphy or feldspar composition, which suggests that crustal assimilation has occurred heterogenously through time at different levels of the magma chamber. It also confirms that crystal exchange occurred betweeen the various parts of the magma chamber, without an overall mixing that would have destroyed the chemical layering of the magma chamber.

References

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5.4.P11

Compositional and isotopic constraints on the formation of coexisting silica over- and under-saturated syenites: The Kangerlussuaq Intrusion revisited

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Syenite intrusions of the East Greenland rifted margin belong to the North Atlantic Igneous Province and formed in a prolonged alkaline magmatic event 5–15 m.y. after continental breakup and tholeiitic flood volcanism at ~55 Ma. The ~800 km^2 Kangerlussuaq Intrusion (50 Ma), which is emplaced into Archaean basement and the overlying flood basalts, is the largest exposed intrusion in East Greenland. It is famous for displaying concentric zonation from quartz-rich nordmarkite (quartz syenite) at the margin, through pulaskite, to foyaite (nepheline syenite) in the centre with no apparent intrusive contacts. In fact, it can be viewed as a layered intrusion that grades from oversaturated syenite at the bottom to undersaturated syenite at the top. Phase relations in the petrogenetic residua system rule out petrogenetic relations through fractional crystallisation. Alkali feldspar isotope compositions vary from the nordmarkites ($^{87}Sr/^{86}Sr_i$ = 0.706; εNd_i = +2.3; εHf_i = +5.2; $^{206}Pb/^{204}Pb$ = 16.98) which seem to have a large crustal component, to the foyaites ($^{87}Sr/^{86}Sr_i$ = 0.704; εNd_i = +3.8; εHf_i = +11.1; $^{206}Pb/^{204}Pb$ = 17.88) that have dominantly mantle signatures. The average Mg# of amphibole cores varies from 26.4 in nordmarkite to 57.4 in pulaskite. These data demonstrate a possible link from foyaite/pulaskite, through concurrent assimilation and fractional crystallisation (AFC), to nordmarkite. However, huge basalt xenoliths of the roof embedded in nordmarkite demonstrate crystallisation from the bottom up. Therefore, AFC in a closed system can be ruled out.

Instead we argue that the nordmarkites crystallised from a mildly undersaturated alkaline basaltic melt driven to oversaturated trachyte by AFC. Repeated recharge by mantle-derived alkaline magma and progressive shielding from the country rocks resulted in the formation of less-contaminated and more primitive syenites, reaching foyaite at the top of the intrusion. Pb isotopes of matrix feldspars with more radiogenic compositions relative to coexisting feldspar phenocrysts and increasingly magnesian amphiboles support such a mixing model.