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OPPOSITE DEVELOPMENT PATHS OF NATURAL SILICATE MELTS CAUSED BY MAGMA MIXING, INTERDIFFUSION AND EXTRACTION

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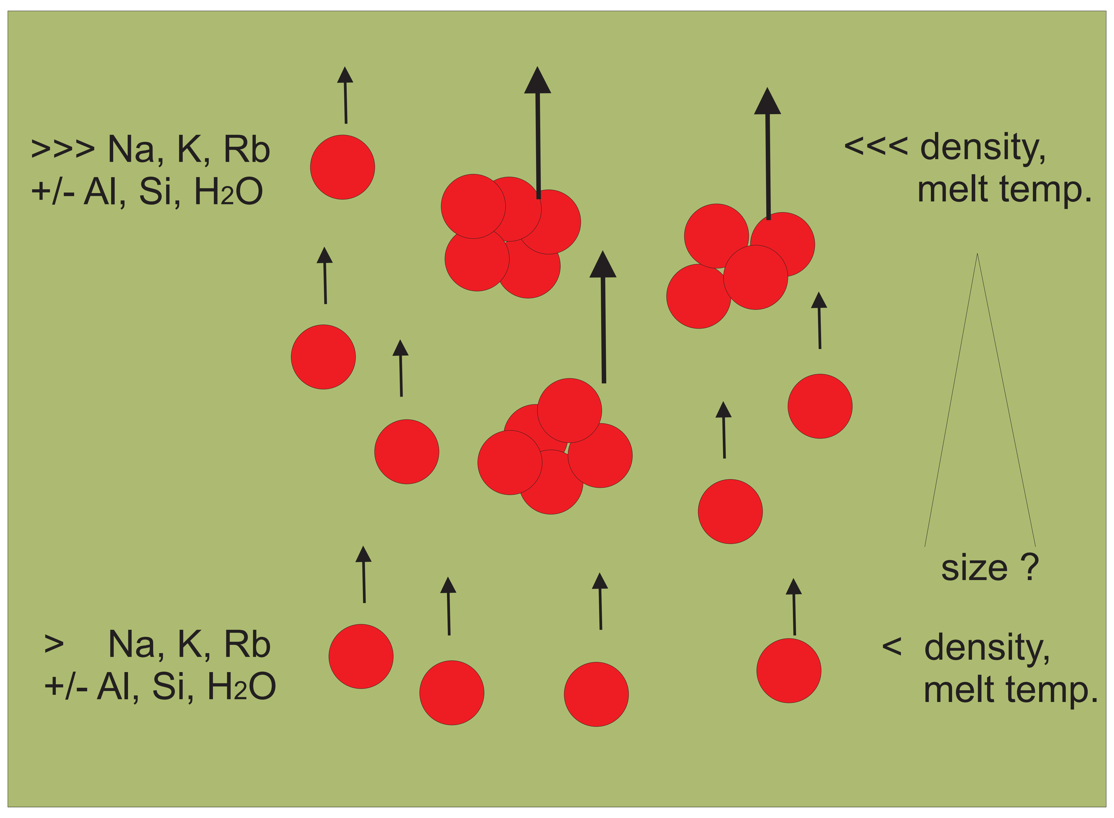
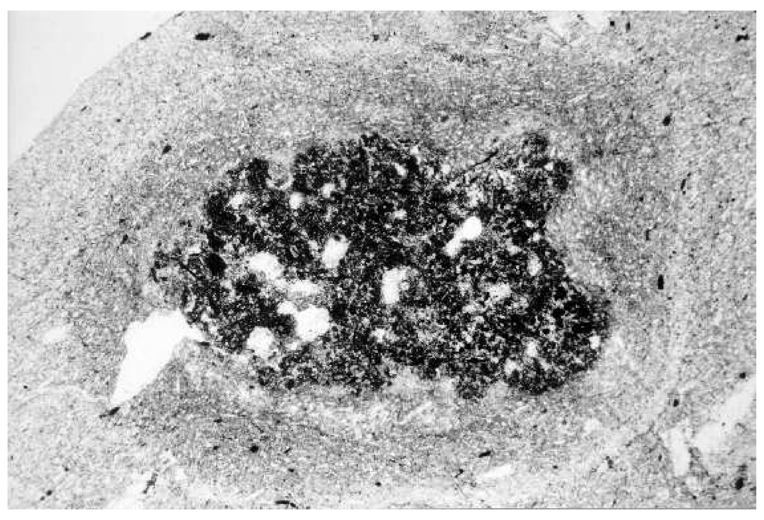
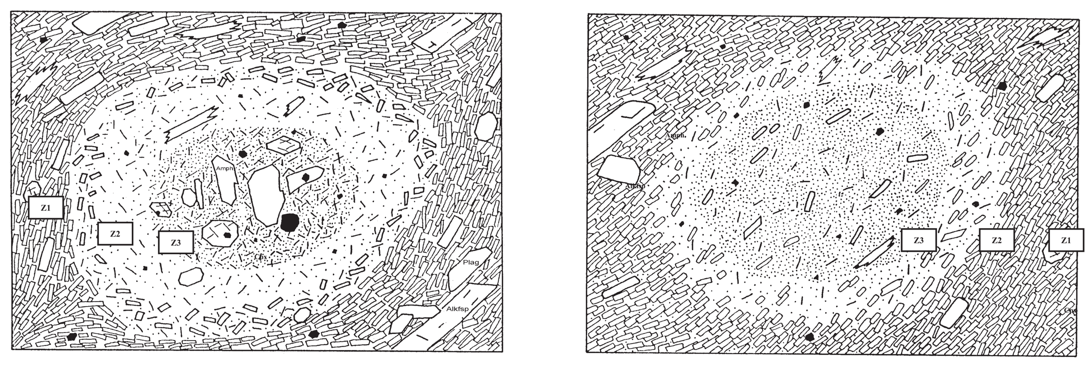
Introduction

Until now, genesis of alkaline melts is a not satisfyingly solved problem. A new model explains the alkali enrichment in the undersaturated alkaline series by an extraction process (Globule Model): during the intrusion of a high temperature melt into a reservoir with a cooler melt, swarms of small melt droplets (globules) of the guest are formed due to surface tensions. Initial inter- diffusion between host and globules is reinforced by convectional movement of the swarms in the magma chamber. As a result, the globules become continuously enriched in alkalis and fluids while the contents of alkaline earths, Fe, and Ti are reduced. Due to the alteration of the globules, their physical properties are changed: density, melt temperature and viscosity of the globules are reduced in respect to the host melt. Therefore, the globules are able to rise up within the magma chamber. Beneath the top of the magma chamber the globules collect themselves generating an extraction melt highly enriched in alkalis and volatiles. Depending on the volume rates, the composition of the host melt is also changed. The degree of compositional change of both melts has been estimated. Generally, the development path of the host leads to the picritic field while that of the guest has a direction to the phonolitic/trachytic field. The magmatic development by the Globule Model tends to a bimodal magmatism that can be observed in many magmatic fields. Zonation of magma chambers depends on the quantity of following intrusions..

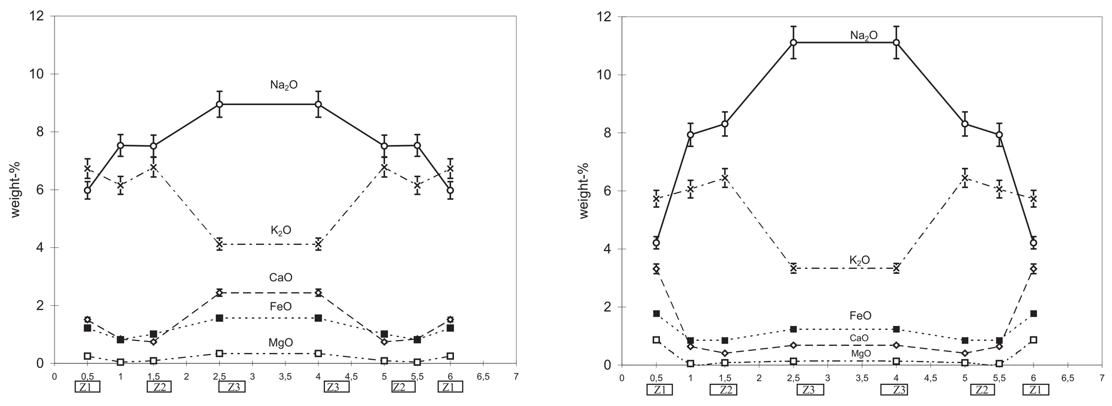




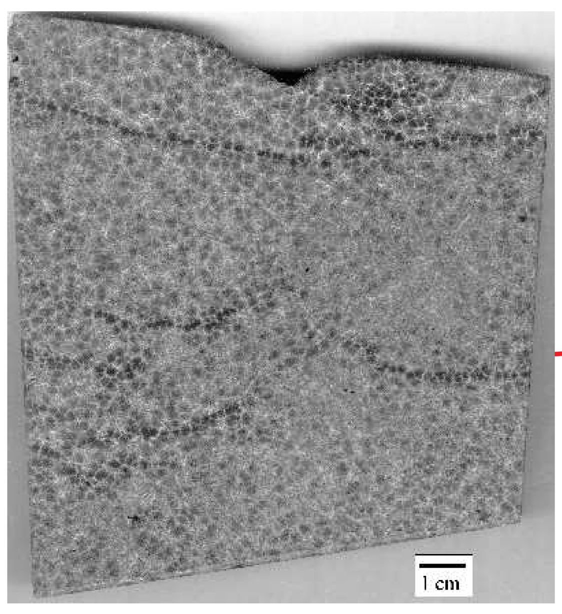
Photomicrograph (plane polarised light) showing the contact between a dark globule (diameter ca. 25 mm) and its trachytic host rock.



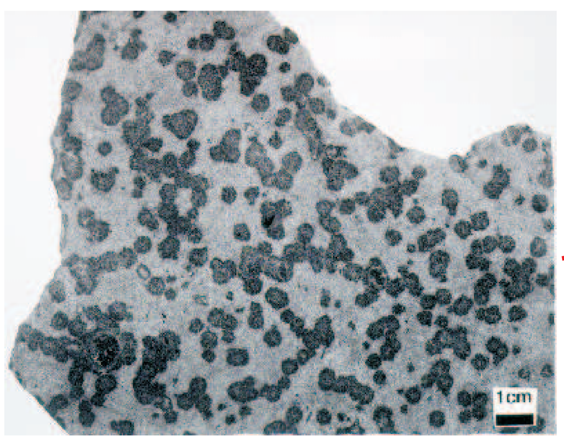
Schematic representation of the mineral assemblage and the texture of globules. Globules and the trachytic contact can be subdivided into three zones based on different textures. Zone 1 (Z1) represents the trachytic host, and zone 3 (Z3) the globule center, while Z2 represents the contact zone. Bar length = 0.5 mm.



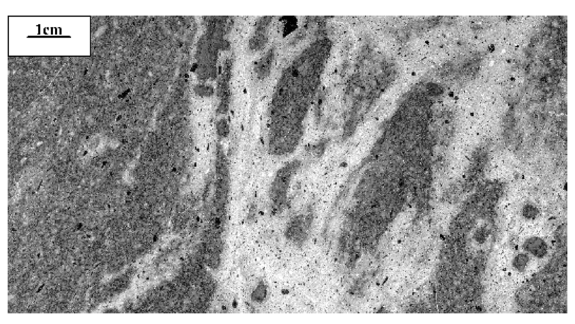
Each zone of globule (Z2, Z3) and the trachytic host (Z1) was measured by a defocused electron microbeam (scan area: 20 mm²). The element plots in weight-% represent the mean values of numerous measurements (n > 10) within each zone presented in an idealized profile.



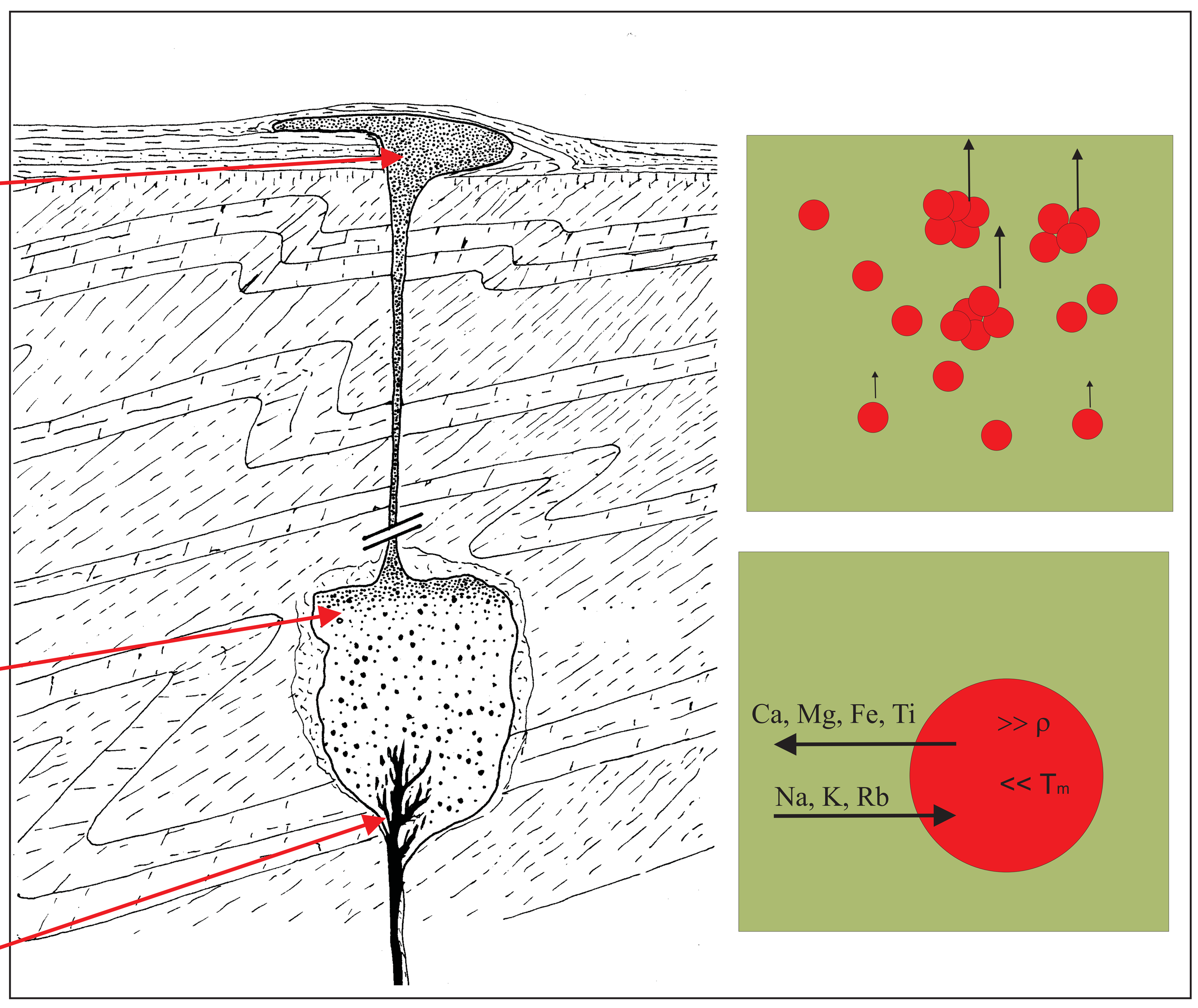
Polished slab of phonolitic trachyte totally composed of globules.



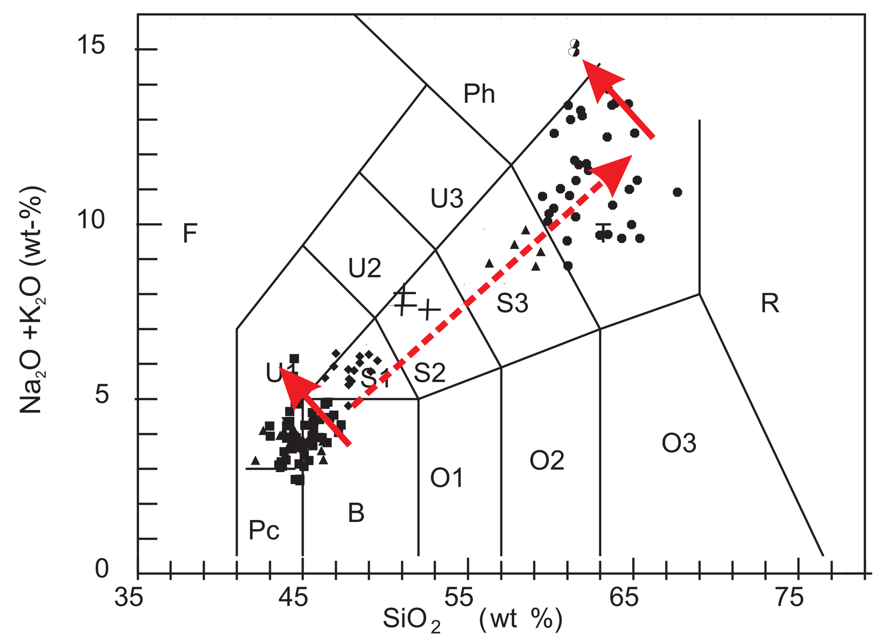
Polished slab of a hybrid rock with dark latitic globules in a trachytic host rock.

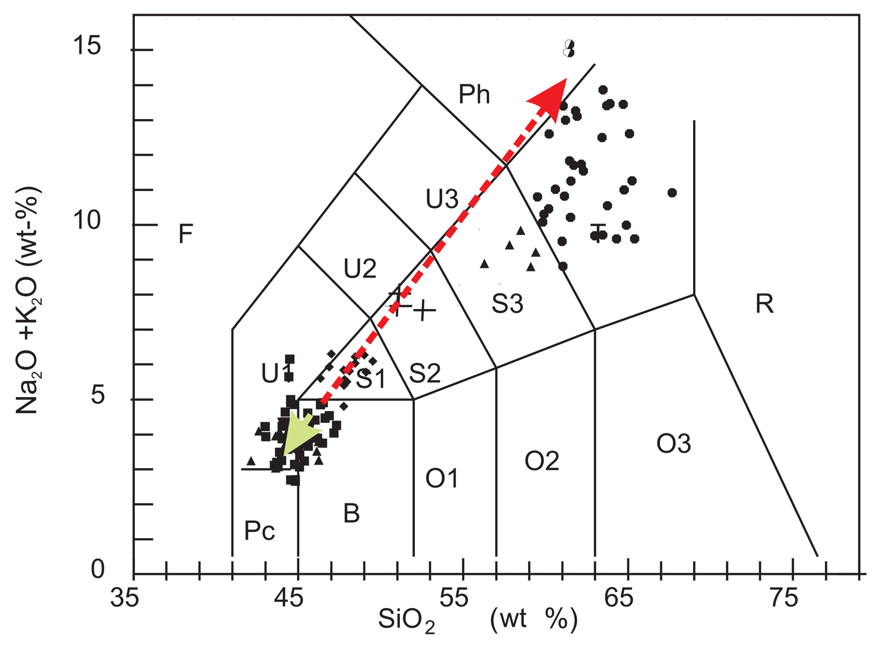


Polished slap of a rock with schlieren (latitic) and emulsified dark globules (diameter ca. 8 mm) in a light gray trachytic host.



Magma mixing model:
- **melt/melt intrusion**
- **development of schlieren and globules**
- **interdiffusion between globules and host melt**
- **changing of physical conditions**
- **rise of globules to the top of magma chamber**
- **eruption - or**
- **development of a zoned magma chamber at the top by repeated intrusions and**
- **layered accumulates of ol/px at the bottom**





XRF analysis values of alkaline volcanics from the Westerwald plotted on the TAS-diagram. An apparent linear development is recognisable from basaltic and basanitic rocks (B, U1) to the saturated series to trachytic rocks (upper diagram). From trachytic rocks a linear trend to globule type alkali rich volcanics exist.
In the lower diagram a development path from globule type mixing processes is shown. The red arrow defines the possible SiO2/alkali - enrichment due to interdiffusion and relativ enrichment. The green arrow shows the trend of the host melt after assimilation of Fe, Mg and Ca.