



Reactive infiltration of picritic magma in the gabbroic cumulates of Rum, Scotland

J. Barraud

Department of Earth Sciences, University of Cambridge, UK (jbar02@esc.cam.ac.uk)

Introduction

New field observations and data from the Rum Central Complex (Scotland) are presented. Detailed field mapping reveals the 3D geometry of an intrusive set of interconnected olivine-rich troctolitic veins and patches situated in the unit 3 bytownite-gabbro (allivalite) of the Eastern Layered Intrusion. This group of invading bodies is clearly related with a mushroom-like 1 m-high discordant pod of peridotite located at the base of the 3 m thick allivalite layer, close to the interface with the underlying unit 3 peridotite.

Field observations

The veins are either discordant with the magmatic foliation or concordant; in which case they show complex alternations of troctolitic rocks, olivine-rich schlieren and discontinuous layers of allivalite. The discordant veins have a lenticular shape; their thickness ranges from 1 to 20 cm and their diameter from a few centimetres to several metres. One example of these veins has a picritic composition (Holness, pers. comm.) but they are mostly olivine-rich bytownite-troctolite. Several examples of crosscutting relationships with clear interconnection between concordant and discordant veins were observed.

The patches are irregular olivine-rich areas with no internal structure, except for embedded pieces of olivine-rich foliated troctolite layers or elongated aggregates of cpx crystals. The contact with their gabbroic surroundings is undulatory and gradational when it crosscuts the foliation whereas it may be sharper and straight when parallel to the foliation. Their size ranges from 10 cm in diameter to 2x3 m broad zones.

The intrusive nature of this network is illustrated by the contact relationships but also

with the apparent reactions of the infiltrating liquid with the solidifying gabbroic crystal mush. The thin veinlets show one-crystal thick (0.5-1 cm) pyroxenite rims. Thicker olivine-rich layers present 1 m-wide cpx-poor troctolitic bands on each side, which are themselves framed by thin pyroxenite rims. The cpx of these rims is oikocrystic and contains numerous plagioclase and olivine chadacrysts. On a larger scale, a broad zone (1-3 m) of poikilitic gabbro surrounds the main peridotite pod and the associated intrusive network. The contact of the poikilitic gabbro with the surrounding medium-grained gabbro is mostly sharp and undulatory.

Similar observations were made on units 8 and 9 in the Askival Plateau area. Again, the presence of intrusive olivine-rich layers is associated with the disruption of the normally homogeneous surrounding allivalite. This perturbation affects the content in cpx and the texture of the allivalite so that poikilitic gabbros with undulatory contacts are generally observed in close association with the olivine-rich layers.

Model and conclusions

These field relationships offer significant insights into the nature and extent of the metasomatising effects of infiltrating liquids during the replenishment of the Rum magma chamber. Hot and undersaturated picritic magma infiltrates the pre-existing crystal pile either by channelled flow or in a more pervasive way to form patches. Numerical modelling of the infiltration with the program Iridium (Boudreau, 2003) shows that, depending on its temperature, the infiltrating liquid would dissolve the gabbroic mush completely (initial picrite $T = \text{liquidus } T$), or would dissolve only the cpx while preserving most of the other phases (initial picrite $T = \text{eutectic } T$). A “cpx-rich liquid” is then formed, displaced by the infiltrating liquid on a centimetre scale and finally recrystallises on the edges of the veins, producing the cpx rims. The field evidence suggests that, when the process occurs on a metre scale, the recrystallisation of the cpx occurs throughout the affected mush, producing the poikilitic gabbro. The high temperature maintained for a long time by the intrusion (low supercooling) and the sustained flow of interstitial liquid favour the crystallisation of big oikocrysts and may explain the poikilitic nature of the gabbro (Mitchell et al., 1998).

References

- Boudreau, A.E., 2003. IRIDIUM—a program to model reaction of silicate liquid infiltrating a porous solid assemblage. *Computers & Geosciences* 29(4), 423-429.
- Mitchell, A.A., Eales, H.V., Kruger, F.J., 1998. Magma replenishment, and the significance of poikilitic textures, in the Lower Main Zone of the western Bushveld Complex, South Africa. *Mineralogical Magazine* 62(4), 435-450.