

A Reply. Petrology of the Hyllingen Gabbro Complex, Sør-Trøndelag, Norway

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Some critical remarks have been put forward by Robins (1974) in this issue on the petrochemical evolutionary trends proposed for the Hyllingen gabbro complex by the present author (Nilsen 1973). Robins is chiefly concerned with the interpretation of the whole-rock analyses presented in the paper and concludes his discussion with a general disbelief of any hypothesis on the magma evolution based on them. His main argument is based on the fact that the samples investigated represent cumulates or products of a magma undergoing strong fractional crystallization and not eight or ten relict magma representatives.

In full agreement with Robins this statement seems self-evident: as stated, unfortunately no convincing exposure of a true magma representative (e.g. chilled margin) has been found within the complex. It is therefore regrettable that Robins misinterprets the plots presented in the diagrams as representative of the magma compositions of the different stages giving rise to the actual specimen (in which some trapped parental might have been incorporated). With reference to the plots in figs. 11 & 12, no suggestion of the parental liquid composition of the actual specimen is given.

The analyses presented were meant to give an idea of the evolution of the *fractionation* products whose composition may delineate the prevailing condition during solidification of the magma. The fractionation pattern as revealed by the early formed iron-titanium oxide cumulates through the series showing an apparently regular decrease with respect to iron is by no means comparable with the Skaergaard cumulates – even though the composition of the parental magma might be of a similar kind. As for the intermediate stages, the fractionation trends are less clear cut, as shown on the diagrams, but an apparently gradual increase in alkalis through the diorites, monzonites and adamellites points towards a fractionation trend comparable with that of the Guadalupe and Baltimore gabbros. These residual derivatives bear no resemblance to the granophyric residua of other layered intrusiva as inferred by Robins, but fit well within the entire plutonic sequence as being well-crystallized, massive rocks. This trend fits very well with a magma model fractionated under high and increasing pO_2 as shown by Osborn (1959, 1962).

One must assume that accessible water has provided the oxygen available in extracting iron and titanium from the parental magma at an early stage, whatever its composition, and giving rise to the high $\text{Fe}^{3+} : \text{Fe}^{2+}$ ratios of the cumulates in analogy with the crystallization history of the Upper Layered Series at Kap Edward Holm, East Greenland (Elsdon 1971).

To make a more systematic collection of average cumulates specially related to those of the successive parental liquids as proposed by Robins is a desirable, if realizable, task, but quite unnecessary to prove that the Hyllingen magma was fractionated under entirely different conditions than the Skaergaard magma during the initial stages of crystallization. In agreement with Robins the true petrochemical nature of the crystallizing magma cannot be solved by the ten analyses alone, however, a calc-alkaline evolutionary trend of the Hyllingen magma appears to be in accordance with the general fractionation trend observed.

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