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

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In a recent paper in this journal Nilsen (1973) presented a description of the southern part of the Fongen-Hyllingen gabbro, a layered intrusion regarded by Birkeland & Nilsen (1971) as emplaced into its Lower Palaeozoic host-rocks either just before or during the earliest stages of the Caledonian orogeny. The intrusion shows both rhythmic layering and extensive cryptic variation, a complete differentiated series extending from peridotites and olivine gabbros to monzonites and adamellites being exposed. Despite subsequent deformation and metamorphism in the amphibolite facies it clearly retains enough of its primary textures and mineralogy for its mode of crystallization to be examined in detail.

On the basis of ten whole-rock chemical analyses, Nilsen attempts to show that the evolutionary trend of the crystallizing magma was a progressive enrichment in silica and alkalies, i.e. of calc-alkaline type, while in the great majority of well-known layered intrusions the early and middle stages of differentiation involve the strong iron enrichment typical of reduced tholeiitic parents. As far as the author is aware only in two other cases, the Guadalupe gabbro (Best 1963) and the Baltimore gabbro (Herz 1951), is this feature claimed to be absent. This important conclusion by Nilsen is based principally on the variation of total iron oxide relative to silica in samples collected on a single traverse across the Fongen-Hyllingen gabbro. If we exclude from consideration two analyses of the highly altered 'ultrabasics' (Nilsen, Table 1, analyses 1 & 2) which Nilsen believes to be unrelated to the gabbro, and the analysis of a cummingtonite–hornblende gabbro (Nilsen, Table 1, analysis 8) sampled in error, the remaining cumulates are claimed to lie along a trend of decreasing $FeO + Fe_2O_3$ and increasing SiO_2 (fig. 1).

This author contends that this trend cannot reflect magmatic evolution, for the following reasons:

The most iron-rich, silica-poor sample (no. 4, fig. 1) can by no means be considered to lie on a liquid line of descent of a basaltic magma.

The monzonites lying at the silica-rich end of the Hyllingen variation are the equivalents of the granophyric residua of other layered intrusions which

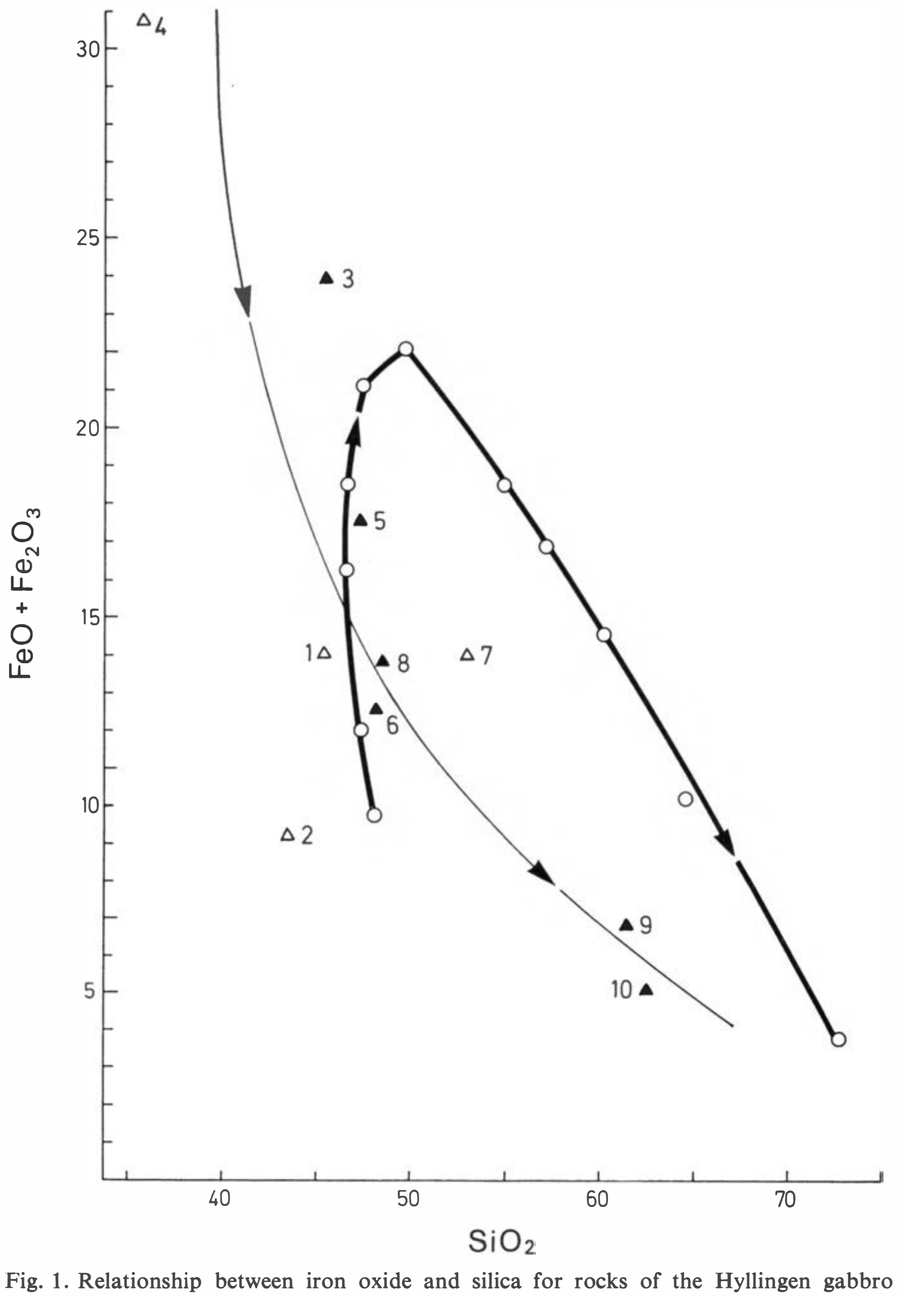

Fig. 1. Relationship between iron oxide and silica for rocks of the Hyllingen gabbro complex (triangles) (Nilsen 1973, Table 1) and estimated compositions of successive liquids of the Skaergaard intrusion (circles) (Wager & Brown 1968, Tables 9 & 10). The numbers are Nilsen's and refer to the position of the samples on a west-east traverse from the base to the roof of the Hyllingen gabbro, and the thinner line the claimed differentiation trend.

in the case of the Skaergaard intrusion resulted from rapid enrichment in silica and alkalies in the liquid remaining after about 99 % solidification (Wager & Brown 1968). Their composition provides, therefore, no evidence of magmatic trends during the middle stages of differentiation.

In terms of total iron oxides and silica the analyses (excluding no. 4) lie close to the complete liquid trend of the Skaergaard intrusion (Fig. 1), as they do when plotted in terms of FeO–MgO–Alkalies (see Nilsen, fig. 12), but with a total lack of chemical sequence relative to their position in the cumulate succession.

In view of the criticisms levelled above, the author believes that rather than proving a calc-alkaline evolution as believed by Nilsen, the analyses presented do not support any prima facie case for the nature of the evolutionary trend for the Hyllingen gabbro. There is certainly no basis for Nilsen's hypothesis that the magma assimilated water and crystallized under a high pO_2. Only when a systematic collection is made of average cumulates whose compositions are specifically related to those of the successive parental liquids will *any* conclusion about differentiation trend be justified.

It is hoped that the arguments advanced here will re-emphasize the dangers involved in the interpretation of analyses of rocks whose compositions largely reflect the mechanical accumulation of crystal phases, and also underline the width of the gap between a petrographical description of the rocks exposed in an intrusion and the sort of computation of the evolution of the parental magma achieved, in extremely favourable circumstances, by Wager & Deer (1939).

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