Further notes on the rift hypothesis for the Seiland Igneous Province

ALLAN G. KRILL

The Seiland Igneous Province in the northern Scandinavian Caledonides is exposed over an area of about 40×90 km. The province consists largely of layered mafic and ultramafic rocks, with lesser amounts of intermediate to felsic rocks, including syeno-gabbro, syenite, and carbonatite. The rocks are remarkable because of their extremely good exposure, their range of tholeiitic to strongly alkaline compositions, and their complex patterns of cumulate layering, high-temperature foliation and cross-cutting dikes.

Interpretations for the Seiland igneous rocks have evolved through the years. The complex relationships led Krauskopf (1953) to interpret the foliated gabbros as gneissified layered volcanic rocks. Sturt & Ramsay (1965) interpreted them as magmatic gabbros, which had intruded during Caledonian orogenesis. When isotopic dates as old as 540 Ma were obtained (Sturt et al. 1967; Pringle & Sturt 1969) the Caledonian orogenic model was revised. The intrusions were still considered to be Caledonian, but the orogenesis here was thought to be Cambrian-Ordovician, rather than Silurian. When isotopic dates as old as 610 Ma were obtained (Brueckner 1973, 1975; Pringle 1975) the orogenic model was not further revised, but since the dates were incompatible with the model they were considered to have no geochronologic significance (Pringle 1975). Krill & Zwaan (1987) proposed a revision which would allow these dates. Now still older dates have been obtained for the Seiland igneous rocks, and the geologic models are clearly in need of testing and improvement.

The purpose of this paper is to advance one of the working hypotheses: that the Seiland rocks represent deeply eroded roots of a long-lived continental rift zone. Since the rift geometry is not apparent in the Seiland remnant, it should be useful to compare the Seiland rocks with the Permian igneous rocks of the Oslo paleorift. Both areas include abundant magmatism, and in each case the ensuing divergent ocean basin developed elsewhere. If the rift model is correct for the Seiland Province, we may here directly observe types of rocks and structures that form the deep continental lithosphere beneath the Oslo graben and other rift zones.

The best-documented interpretation for the Seiland Province is that it represents an extensive complex of plutonic rocks, derived in large part from mantle depths, to intrude Ordovician to Late Proterozoic metasediments and their crystalline basement during early Caledonian orogenesis. From a combination of isotopic dates and structural and petrographic data, this 'Finnmarkian' orogenic event was shown to include two main fold-deformation phases, to which the chronology of the intrusions was related in detail (see Sturt et al. 1978). On western Sørøya, for example, the Breivikbotn gabbro was shown to have intruded during the first deformation phase, the Hasvik gabbro intruded between phases D1 and D2, and the small monzogranite pluton was syn-D2. Mafic dikes intruded before, during and after the deformation phases. These phases were correlated regionally with deformation phases elsewhere in Finnmark.

From a brief visit to this key area of western Sørøya, Krill & Zwaan (1987) suggested that all of the intrusions were older than all of the orogenic deformation. Some intrusions clearly cut folds and chaotic migmatitic structures, but these structures were interpreted as contact-metamorphic and not orogenic. Thus the intrusions of the Seiland Province could be related to pre-Iapetus continental rifting. Sturt & Ramsay (1988) refuted this interpretation. They returned to the Sørøya area, and from the migmatitic contact aureoles they collected photographs of dikes cutting structures that strongly resemble orogenic folds. They maintained that the folds were orogenic and could be related to folds outside of the aureoles. They also revised their structural interpretation for the Hasvik gabbro, suggesting that it intruded "syn-to post-F2". The Hasvik gabbros has been dated at 706±36 Ma (Aitcheson, unpubl.poster 1988, Aitcheson et al. 1989), effectively dating this 'F2' deformation. Krill & Zwaan (1988) repeated their suggestion that dikes do not cut folds outside of the contact aureoles, and that the dikes and gabbros could be pre-Caledonian and pre-orogenic. A correct structural interpretation here is essential for interpretation of the Seiland Province and the regional geology of western Finnmark. Although B. Zwaan has studied similar migmatitic structures in northern Troms, we have not had the opportunity to return to the Sørøya area and more carefully investigate the migmatitic folds there. We hope that others will do so. To encourage such structural geologic research, I try to show here why the rift interpretation for the Seiland Province must still be considered a viable hypothesis.

Results from a new round of isotopic dating in western Finnmark are now appearing as abstracts from a number of geological meetings (e.g. Daly et al. 1988, Aitcheson et al. 1989, Aitcheson & Tayler 1989, Mørk & Stabel 1989,