A stylolitic marble from the Caledonian metasedimentary sequence of southern Troms

ROBIN NICHOLSON

Nicholson, R.: A stylolitic marble from the Caledonian metasedimentary sequence of southern Troms. *Norsk Geologisk Tidsskrift,* Vol. 56, pp. 321–324. Oslo 1976.

A marble, with many tectonic stylolites cutting its metamorphic fabric, is reported from the Finnsnes area of southern Troms. The marble is obviously part of the high-grade Caledonian metasedimentary sequence. However, neither here nor elsewhere in the metamorphic tract of the Scandinavian Caledonides have stylolites previously been recorded.

R. Nicholson, Department of Geology, The University, Manchester, M13 9PL, England.

In the summer of 1974, thanks to an opportunity provided by Norges Geologiske Undersøkelse, through the good offices of Tore Birkeland of Universitetet i Tromsø, 16 days were spent on field work in the Finnsnes area of southern Troms. On the fourteenth day a marble rich in stylolites was discovered on the banks of Jøvikelva (Fig. 1). Neither here nor elsewhere in the metamorphic tract of the Scandinavian Caledonides have stylolites previously been recorded.

Description

Both Figs. 2 and 3 show the distinctive irregular zones which are the subject of this account. Note that the peel print of Fig. 2 amounts to a negative print while the photomicrograph of Fig. 3 is a positive one. The zones, in which are concentrated both the carbon and the small feldspar crystals found scattered through the equigranular calcite fabric that forms the rest of the rock, are obviously stylolites, i.e. surfaces which are on average normal to the principal compressive deviator stress and on which solution transfer has led to loss of calcite and concentration of insolubles.

The Jøvikelva stylolites not only closely resemble the seismograph or sharp-peaked stylolite types distinguished by Park & Schot (1968) from unmetamorphosed calcite rocks (limestones), but cut the obviously metamorphic fabric. Thus the stylolites cannot be structures surviving from the parent limestone but must be younger than the post-tectonic Caledonian recrystallization.

The stylolites with longest columns (Park & Schot 1968), 10 to 20 mm, generally lie sub-normal to the well-developed bedding of the grey-white Jøvikelva marble which here dips northwest at varying angles. They are

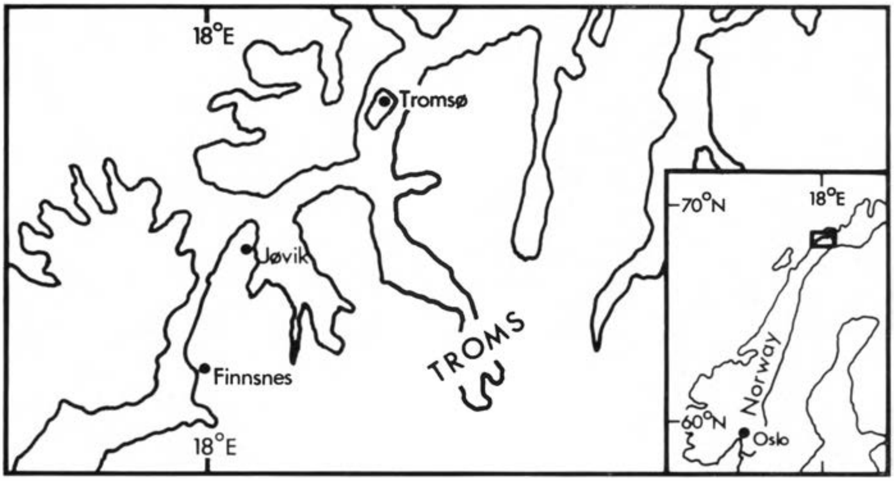

Fig. 1. Locality map of southern Troms.

transverse stylolites in Rigby's terminology (Rigby 1953). However, there also are stylolites of a variety of other attitudes, including some parallel to bedding, but then generally with much shorter columns. There is evidence in the marble too of the successive development of stylolites of different attitudes and in fact the stylolite complex gets close to resembling the interconnected network recognized as a distinct class by Park & Schot (1968).

No examples of precipitation related to stylolite formation occur in the marble. The calcite crystals of veins which cross bedding have the same equant polygonal crystal shape as crystals of the rock outside them; thus the veins too are likely to be older than the stylolites.

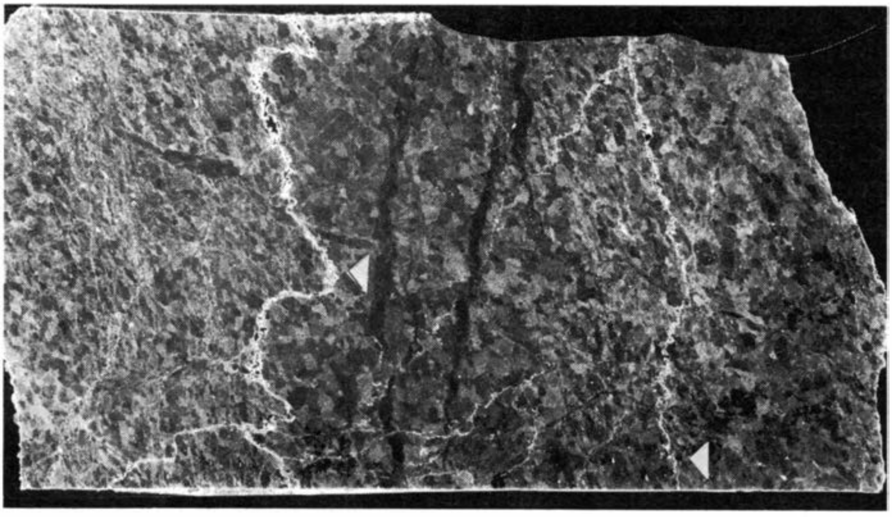

Fig. 2. Peel print from the stylolitic Jøvikelva marble. Arrows mark stylolite seams.

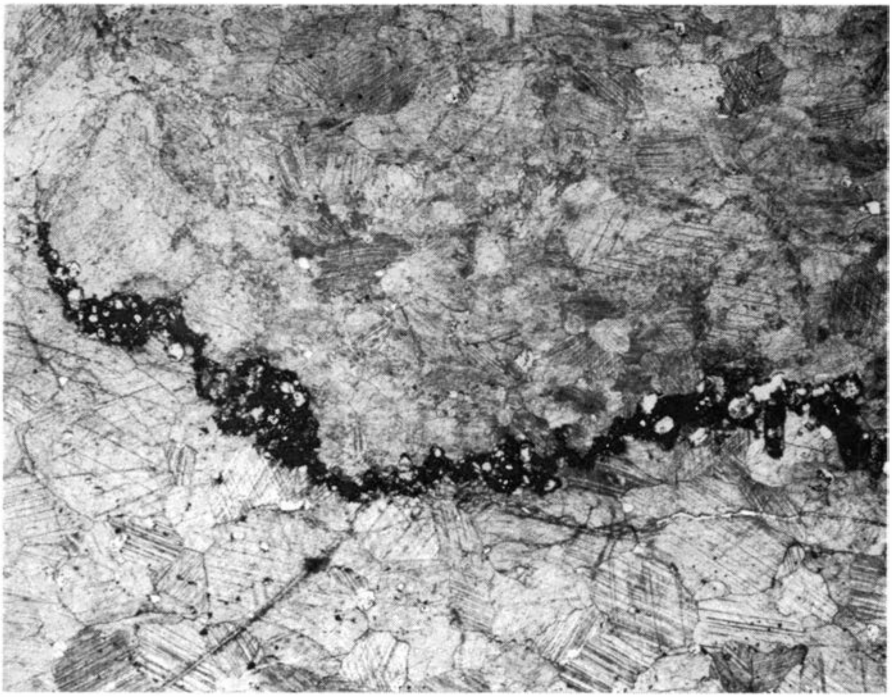

Fig. 3. Photomicrograph of a stylolite seam in the Jøvikelva marble.

Circumstances of stylolite development

The development of the common stylolites of limestones is usually attributed to solution transfer during diagenesis (Park & Schot 1968), a process that obviously requires only low temperatures and a low principal compressive deviator stress of gravitational origin. Dissolution into a water phase in permeable zones, usually parallel to bedding, combines with migration of solute along them to produce shortening normal to the load through volume loss. The migration is sometimes attributed (Park & Schot 1968) to bulk flow through the permeable limestone; eventual loss of porosity through precipitation is supposed to bring stylolite growth to an end.

Durney (1972), considering post-diagenetic solution transfer driven by tectonic stresses in non-porous rocks, assumes that solute migration is chiefly accomplished by diffusion of ions through an aqueous 'solution film' between crystals. Laubscher (1975), however, has suggested that grain-to-grain solution transfer in calcite rocks cannot take place and that permeability produced after diagenesis is required to form post-diagenetic stylolites. Here a distinction is being made between solution transfer, in which water plays an essential role, and grain boundary diffusion which can take place in dry rocks. The role of water is not the only difference between the two; solution transfer is obviously a process active at low temperature and pressure, where water and adequate permeability are available, while grain boundary diffusion is negligible until temperatures are considerably higher, but can then take place in essentially impermeable rocks.

Formation of the Jøvikelva stylolites

The formation of stylolites in the crystalline Jøvikelva marble seems to require water-containing zones, many cutting bedding, formed after metamorphism and from which stylolites developed. These zones could well have been the tension fractures or joints from which Rigby (1953) suggested his class of transverse stylolites formed. The axis of maximum principal compressive stress may have lain in bedding since the most prominent stylolite set lies sub-normal to bedding. Then, if no post-stylolite rock rotation occurred, this stress axis was horizontal during their formation and could not be of gravitational origin. The Jøvikelva stylolites are tectonic stylolites.

To the writer's knowledge no stylolites have been reported before from marbles of the metamorphic tracts of the Scandinavian Caledonides. Nor has he seen any himself in any of the numerous marbles he has examined in the marble-rich tract between Mo i Rana and Troms, although all, of course, are invariably well-jointed.

The Jøvikelva marble appears to the writer to form an ordinary part of the local meta-sedimentary sequence yet it alone of the local marbles contains stylolites. Landmark (1973), however, described Jøvikelva as partly occupying a fault zone and some of the marble there as brecciated. It may be, however, that the appearance of brecciation in fact reflects an extreme of net-work stylolite development. In fact, the writer can find no reports of a genetic association of stylolites and faulting, although the presence of a fault zone connecting a jointed Jøvikelva marble with some water supply would be useful evidence in the attempt to explain the concentration of stylolites in only one marble. There is a clear association, however, of stylolites with folding (see e.g. Laubscher 1975, p. 251 for Jura limestones) although no such relation was observed at Jøvik. Nor were any related structures distinguished in the non-carbonate members of the sequence at Jøvik. Hence the stylolites of the Jøvikelva marble remain without local explanation, but they do promise, on further examination, to add an interesting extra late event to the regional tectonic history.

November 1975

REFERENCES

Durney, D. W. 1972: Solution transfer, an important geological deformation mechanism. *Nature 235,* 315–317.

Landmark, K. 1973: Beskrivelse til de geologiske kart "Tromsø og Målselv" Del II, Kaledonske Bergarter. A. Teksbind. *Tromsø Mus. Skr. Vol. XV,* 263 pp.

Laubscher, H. P. 1975: Viscous components in Jura folding. *Tectonophy. 27,* 239–254.

Park, W. C. & Schot, E. M. 1968: Stylolites: their nature and origin. *J. Sed. Petrology 38,* 175–191.

Rigby, J. K. 1953: Some transverse stylolites. *J. Sed. Petrology 23,* 265–271.