It is clear that a definitive model of medial moraine development should take account of many influences; in particular instances some of these may be present (e.g. lateral compression, extending flow), in others not. A systems diagram showing the operation of these influences is given in Figure 1. On this it is emphasized that as the differential ablation ratio exceeds 1 (i.e. ablation over clean ice is greater than that over moraine-covered ice) moraine height will be increased. However, where the differential ablation ratio decreases below 1 moraine decline sets in; the only other factor seemingly capable of decreasing moraine height is extending flow—and it is difficult to see this is more than a relatively minor factor in terms of its *direct* reduction of moraine height by ice attenuation.

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SIR,

Morphology and development of medial moraines: further comments on the paper by R. J. Small and M. J. Clark

I have been working on medial moraines with particular reference to their sedimentology for the past two field seasons. Last year's operations were based on Austerdalsbreen, Jostedal, Norway: a similar glacial environment to that described by Drs Small and Clark in their paper. Their basic model of medial moraine formation, with its reliance on a lower limit of englacial debris controlling moraine morphology, can be corroborated by the Norwegian example. This is what I have called elsewhere (Eyles, in press) an "ablation-dominant" model of moraine formation.

To invoke lateral compression between merging ice streams of large valley glaciers as contributing to resultant medial moraine morphology is appealing. Ice structures found in this area are, superficially, akin to boudinage in rock (see Anderton, 1970). Certainly, a similar mechanism may explain peculiarities of moraine from down-glacier; increasing height occurring concomitant with decreasing width, for instance. The latter, as Drs Small and Clark will confirm, is opposite to that developed on the lower Glacier de Tsidjiore Nouve, Valais, and from that described from Austerdalsbre, Norway, where medial moraine form is typical of an "ablation-dominant" model of moraine formation (Eyles, in press). Such a model is certainly dependent upon a lower limit of englacial debris controlling moraine morphology (Small and Clark, 1974).

However, as Drs Small and Clark suggest, the effect of lateral compression is in all probability indirect. Longitudinal attenuation of debris quantity down-glacier from confluence areas *may* contribute to the narrowing of moraines commonly observed in such areas. This factor is currently under investigation on Berendon Glacier, British Columbia. Any substantive statement must of course await field results. By virtue of the absence of any well-developed lower limits of englacial debris, important subglacial debris components may be added to the moraine, in the terminal area. Exciting techniques for discriminating sub-components of glacial debris systems (englacial, subglacial and supraglacial sediments) are currently being scrutinized within the framework of medial-moraine sedimentology.

One other point of concern is that of the significance of debris added to medial moraines by ogive bands. On Austerdalsbreen, substantial contribution to moraine debris made by a well-developed ogive suite is lacking; debris of the dirty summer ogive bands is diffuse only. An immature beading of the

moraine in harmony with summer ogive troughs (where diffuse surficial debris lowers the differential ablation ratio below 1) can be explained by mass movement of moraine sediments over the flanks of the ice core into such areas. Clearly, moraine form is an ambiguous indicator of moraine dynamics.

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SIR,

Morphology and development of medial moraines: reply to further comments by N. Eyles

We are grateful to N. Eyles for his further comments. We would like to add two minor points only. First, our experience of medial moraines in the Valais suggests that lateral compression is not an important factor here; instead, all moraines become progressively wider down-glacier, mainly as a result of lateral debris sliding. Sometimes this widening is most pronounced very close to the glacier snout (though this is not so, of course, on the Glacier de Tsidjiore Nouve), where—as Mr Eyles rightly suggests—subglacial debris components may be added to the moraine, increasing differential ablation, heightening the moraine ridge and accelerating lateral debris sliding. Secondly, we are especially interested in Mr Eyles's comment on the immature beading of the Austerdalsbre moraine, which he explains in terms of mass movement of moraine sediments into summer ogive troughs. This mechanism, which seems a highly probable one, would clarify the problem of explaining the *apparent* concentration of englacial debris in summer ogives, when in our view the source of the debris is most likely to be well above the ice fall on which the summer ogive is supposed to have developed.

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