16.5: Cross Stratification Not Produced by Climbing Bed Forms

After all of the voluminous material above on how to deal with cross stratification produced by trains of repetitive bed forms that climb at some angle owing to net aggradation of the bed, I think that it is important to point out here that not all cross stratification is produced by bed forms climbing at some angle—although I think it is fair to say that most of the cross stratification you see is indeed formed in that way.

One obvious case in point is rather obvious, and has been touched upon in the earlier part of this chapter:

- A train of flow-transverse bed forms is produced by a neutral flow (by “neutral” I mean that there is neither net aggradation or net degradation) over a loose sediment bed, then the flow stops, and later the train of bed forms is mantled or draped by sediment deposited in such a way as not to disturb that underlying train of bed forms (by fallout without traction, for the most part).

I might term this kind, unofficially, **single-bed-form-train cross stratification**.

I have already shown one example of single-bed-form-train cross stratification in Figure 16.4.9, wherein two-dimensional oscillation ripples are formed and shift slowly with no net addition of sediment to the bed. Single trains of unidirectional-flow ripples are more common. Cross stratification of this kind is especially common in deposits of distal turbidity currents. The situation is this: an almost exhausted turbidity current sweeps by a point, depositing fine sand, and molds that sand into a train of ripples. Although the bed is aggrading while the ripples are moving, the total thickness of sand added to the bed is not enough to form a layer more than one ripple thick (Figure \(\PageIndex{1}\)A). In fact, in many such cases the ripples end up starved, in the sense that the difficultly erodible substrate is exposed in the ripple troughs (Figure \(\PageIndex{1}\)B). Of course, as the total thickness of sediment added to be bed increases, the degree of overlapping of ripples (whereby ripples start
climbing up the backs of others) increases (Figure \(\PageIndex{1}\)C), and eventually the picture is as described in the earlier section on classic climbing-ripple cross stratification.

![Figure \(\PageIndex{1}\): Single-ripple-train cross stratification. A) Full single train. B) Starved train. C) Ripples starting to overlap.](image)

Usually the material presented so far in this section is relevant to small-scale bed configurations—ripples of various kinds—but sometimes single trains of much larger dunes are formed and then interred within different, or at least differently structured, sediment. When the dunes have large spacings and small height-to-spacing ratios, there is the added complication that you may on the outcrop see a segment of a dune that is very short relative to the dune spacing, and the cross stratification looks like a planar-tabular set with uniform thickness (Figure \(\PageIndex{2}\)). I know of no way of knowing, just from looking at an outcrop like Figure \(\PageIndex{2}\), what the original spacing of the dunes was—or even if I am really dealing with a train of dunes in the first place!

![Figure \(\PageIndex{2}\): A planar-tabular cross set that represents a small part of single large dune-like bed form.](image)

In a situation like that shown in Figure \(\PageIndex{2}\), there is also the problem of whether the full height of the dune is preserved. You might find features at the upper surface of the cross set that gives evidence of its having been the exposed upper surface of a dune, like superimposed smaller bed forms. Although that is not foolproof, it would suggest strongly that the dune was not eroded or shaved off by a later strong current after its own driving current ceased.

Finally, cross stratification can be formed by the progradation of the sloping surface of an isolated element of positive relief, like a fluvial sand bar or a submarine shoal or a delta body. Scales of such features can range up to very large. Deciding between this situation and the one described above (a small part of a single train of dunes) would be impossible without a degree of lateral control not usually available in outcrop.
Chapter 16 Reading List


Cheel, R.J., 1990, Horizontal lamination and the sequence of bed phases and stratification under upper-flow-regime conditions: Sedimentology, v. 37, p. 517-529.


Hunter, R.E., 1977b, Terminology of cross-stratified sedimentary layers and climbing-ripple structures: Journal of


Skipper, K., 1971, Antidune cross-stratification in a turbidite sequence, Cloridorme Formation, Gaspé, Quebec: Sedimentology, v. 17, p. 51-68.

