Recognition

Invariable two-dimensioinal bedforms and cross-bedding

As a result of simple bedform morphology, all cross-beds and bounding surfaces generated by a set of identical two-dimensional bedforms have identical strikes (Fig. 1). This characteristic is visible in block diagrams, particularly in horizontal sections, and also in plots of cross-bed and bounding-surface dips (as illustrated in all computer-generated images in Figs. 1-29). This category of invariable two-dimensional structures includes most structures that have been called tabular sets of cross-beds. Not all tabular sets are two-dimensional, however; some sets with relatively planar set boundaries have cross-beds that are curved in plan form (Figs. 32, 33, and 44).

Cross-beds deposited by invariable two-dimensional bedforms are geometrically identical at all locations in the structure. Along-strike similarity of the bedding results from along-crest similarity of the bedforms, and down-dip similarity of the bedding results from the invariability through time of the bedform shape and behavior. Bounding surfaces scoured by invariable two-dimensional bedforms have the form of parallel planes, a characteristic that results from the migration in a constant direction of the parallel linear bedform troughs. Parallelism of bounding surfaces is recognizable in outcrops and in polar plots, on which the dips of bounding-surface planes plot as a single point (Figs. 1 and 5).

Variable two-dimensional bedforms and cross-bedding

Variable bedforms change in morphology or path of climb while they migrate. Morphologic variability of two-dimensional bedforms is restricted to changes in height, spacing, asymmetry, or other parameters that determine across-crest profile. No other changes in morphology are possible without making the bedforms three-dimensional. Behavioral variability of two-dimensional bedforms is restricted to changes in the path of climb; changes in the path of climb can be caused by changes in the rate of deposition or changes in the rate of bedform migration.

Changing either the morphology or path of climb (or both) causes bounding surfaces scoured by two-dimensional bedforms to be curved instead of planar. The curved bounding surfaces produced by variable two-dimensional bedforms all have the same strike, whereas the curved bounding surfaces scoured by migrating three-dimensional bedforms vary in strike. These characteristics are recognizable in outcrop and in plots of bounding-surface dips; dips of cross-beds and bounding surfaces produced by variable two-dimensional bedforms plot along a single line through the center of the plot (computer images in Figs. 1 and 13-29).

Invariable three-dimensional bedforms and cross-bedding

Invariable three-dimensional bedforms have a simpler behavior and more complex morphology than variable two-dimensional bedforms. The complex bedform morphology includes surfaces that dip toward a variety of directions; migration of these complex surfaces produces cross-beds that vary in direction of dip. These variations in dip direction can be seen in horizontal sections and in the dispersion of cross-bed dips in polar plots (Fig. 1). In contrast to the planar bounding surfaces scoured by invariable two-dimensional bedforms, the bounding surfaces scoured by three-dimensional bedforms are curved or trough-shaped (computer images in Figs. 1 and 32-79). Polar plots of the computer-generated bedding illustrate that the trends of the axes of such trough-shaped sets of cross-beds can be determined without direct observation of the axes. Trough-axis trends can be determined from random measurements of the poles of the bounding surfaces of the trough-shaped sets; the trend of the trough axis is normal to the line along which the bounding-surface poles plot.

Variable three-dimensional bedforms and cross-bedding

Three-dimensional bedforms can undergo a variety of changes that make the bedforms variable: morphologic changes such as fluctuations in height, asymmetry, or crestline sinuosity, or behavioral changes such as fluctuations in the speed or direction of migration of the main or superimposed bedforms. These changes cause the trough-shaped bounding surfaces scoured by the topographically low scour pits in the bedform troughs to become irregular. The irregularity can result from the up-and-down scour-pit migration caused by fluctuating depth of scour pits or from the back-and-forth migration of scour pits caused by fluctuating migration of the main bedforms or superimposed features.

Irregularity of the bounding surfaces is apparent in outcrop, particularly in horizontal sections, where paths of scour-pit migration are displayed most clearly. Irregularity of the bounding surfaces is also evident in plots of dips of bounding surfaces, because the dips plot as scatter diagrams (computer images in Figs. 1 and 58-79). In contrast, invariable two-dimensional cross-bedding has polar plots in which bounding-surface planes plot as a single point, two-dimensional variable cross-bedding has polar plots in which poles of bounding surfaces and cross-beds plot along the same line, and invariable three-dimensional cross-bedding has polar plots in which bounding surfaces plot as lines that are transverse or oblique to the direction of cross-bed dip.