

## SEDIMENTOLOGY

### PALEOCURRENT STRUCTURES

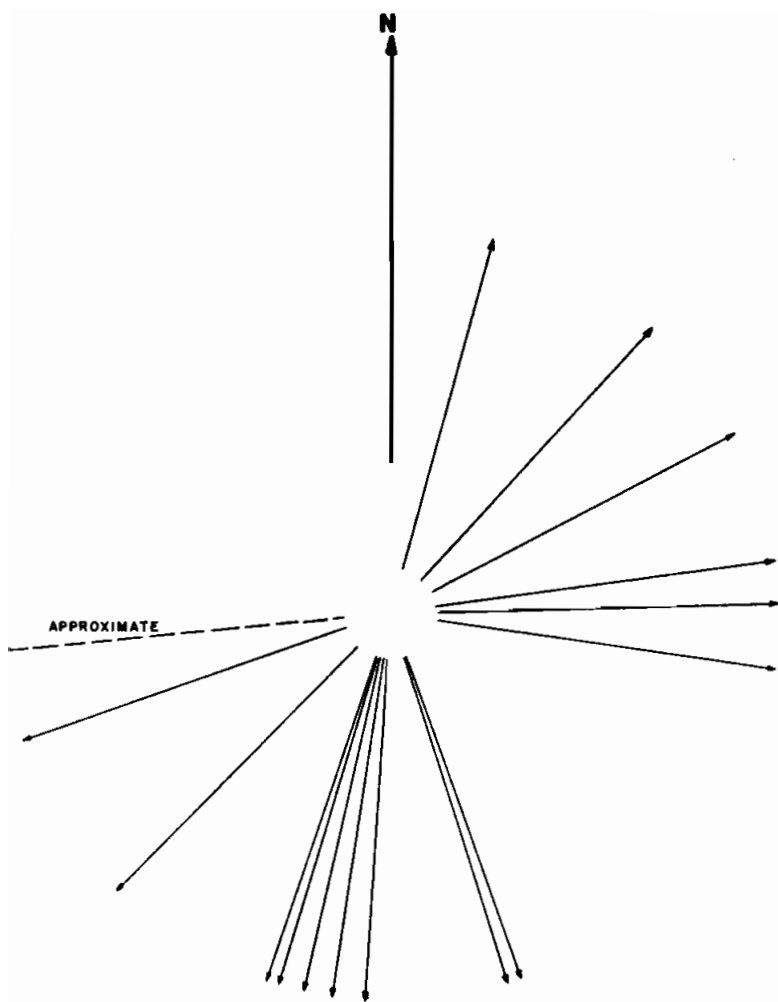
In an attempt to determine the direction, or at least the orientation of the currents which transported these Silurian sediments, small scale cross bedding and ripple marks were examined.

The orientation of the ripple marks, and the attitudes of the containing beds, were recorded. Through use of stereographic projection, the beds were graphically rotated into the horizontal to determine the original orientations of the ripples.

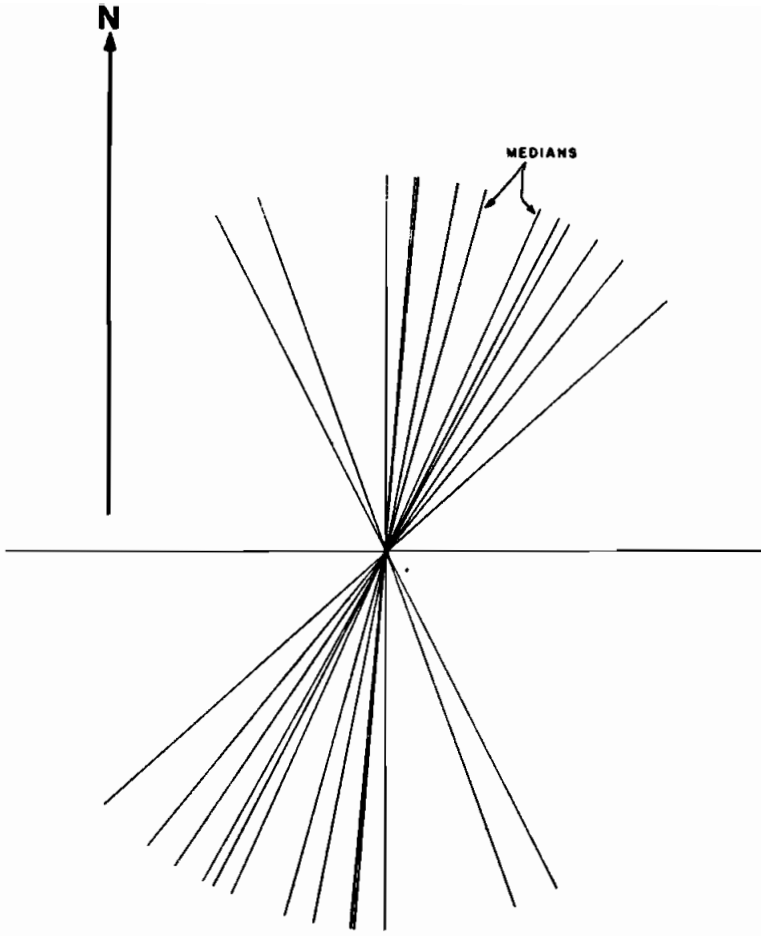
Oriented samples of small scale cross beddings were collected, and the attitudes of the containing beds recorded. The samples were typically about 3 inches by 3 inches by 1 inch in size. Two saw cuts were made at right angles, and the apparent dips measured on these cut surfaces. The true dip of the plane passing through these two apparent dips was calculated graphically. This plane approximates the slightly curved surface of the cross bed. The portion of the cross bed sampled, and the approximate attitude calculated, are of a random segment of the primary feature. If the cross beds are the foreset beds of a distinctly lobate structure, the possible attitudes found from a single such structure may vary by almost 180°. Since the individual structures will vary in direction about the mean current direction, the result to be expected from this study would be a wide scatter of dip directions approximately centered about the direction of the current.

The results of these studies are shown in figures 5 and 6. The directions of the dips of the cross beds, fig. 5, are widely scattered, as was expected. The complete absence of dips into the northwest quadrant, and the presence of only one relatively inaccurate direction of dip within 15° to either side of the northwest quadrant, indicates no current flow to the northwest. The distribution of dip directions is bimodal and may be indicative of two directions of current flow, one about south southwest and the other about east northeast. In view of the small sample, however, the distribution may represent the scatter about a single current direction. The paucity of dip directions in the southeast quadrant must then be attributed to change in the sampling. The direction of this single current system would have been to the southeast. The total lack of dip directions in the opposite quadrant lends credence to this hypothesis.

The ripple marks examined in Pictou County are all symmetrical, though not all have the sharp crests of oscillation



**FIG. 5**  
**SMALL SCALE CROSS BEDDING**  
**DIP DOWN DIRECTIONS**



**FIG. 6**  
**RIPPLE MARK ORIENTATIONS**

ripples. Their orientations, as shown in fig. 6, suggest a normal, rather than bimodal, distribution. Current ripples are oriented perpendicular to the current direction. The orientation pattern of symmetrical ripples is less well understood, but has been observed to parallel that of a symmetrical current ripples and to be perpendicular to the current direction, as indicated by cross bedding (Pettijohn, 1957, p 187). If this is the case in Pictou County the orientations would indicate a single current system to the east southeast or west northwest. The cross bed data rule out the latter.

In summary, the orientations of the ripple marks, and the directions of dip of the cross beds, taken together, indicate a current system in which flow was to the southwest.

## SEDIMENTARY HISTORY

### Pictou County and Vicinity

The same stratigraphic sequence is present throughout northeast Pictou County, and in Antigonish County at Arisaig. The oldest of these rocks are predominantly banded slates and argillites. These represent fine grained sediments deposited in generally quiet water. Several sedimentary iron beds are present, and in the adjacent beds are inarticulate brachiopods, indicating a marine origin for at least part of these beds. The age of these rocks is probably Ordovician.

Following this, came a period of vulcanism, represented by the Bear Brook Formation. During this time, flows and tuffs were deposited at Arisaig in Antigonish County, and in the area from Parks Falls to the French River in Pictou County. Elsewhere in these two counties, tuffaceous sandstones and conglomerates represent this period of vulcanism. The presence of tuffs indicates that volcanoes existed above sea level at this time, whereas the tuffaceous sandstones exhibit cross bedding indicative of deposition in water. Two volcanic islands can thus be located; one at Arisaig, the other in the Parks Falls-French River area.

A space of time elapsed during which an uneven erosional surface was developed on the flows. Sedimentation began again, with the deposition of the Beechhill Cove Formation. This formation is similar to the remainder of the Arisaig Series.

The sediments that form the Arisaig Series were deposited as a succession of muds and muddy, fine grained sands, alternating in irregular and relatively thin strata. Many of these strata contain small, irregular patches and lenses of different grain size. These resemble features shown in samples taken from relatively shallow, near-shore locations in several studies

of recent sediments. Small scale cross bedding and ripple marks (predominantly oscillation ripples) are common primary features at some horizons. Graded bedding, flow casts, and various groovings associated with turbidity current deposits are not present; however, slump rolls over 2 feet in diameter and many feet long, are present in at least one bed near the base of the Moydart Formation, both in Pictou County and at Arisaig. These record an instance of extensive slumping of the uncompacted sediments.

The upper member of the Moydart Formation is composed of red siltstones, some of which contain limy algal (?) nodules. Near the top of the Stonehouse Formation is a mottled red and green sandstone. The color of these red beds is the result of ferric iron present in hematite. They are believed to represent sediments periodically exposed to the air.

These features of the Arisaig Series, together with its shelly fauna (predominantly brachiopods, but including crinoids, pelecypods, gastropods, trilobites, corals, and only rarely, graptolites) imply a relatively shallow water and near-shore environment of deposition.

One exception to the shelly fauna exists. The lower member of the Ross Brook Formation at Arisaig is a sequence of thin black shales with an abundance of graptolites. To the west, at its only exposure in Pictou County, it is composed of light gray mudstones in beds several inches thick. The graptolitic black shales are overlain and underlain by beds of shallow water origin, and are limited in lateral extent. Their origin, therefore, is attributed to a local reducing environment rather than to the deep water environment hypothesized for more extensive graptolitic black shale deposits.

At least 13 tuff beds are present in the lower member of the Ross Brook Formation at Arisaig. Only 2 are present in the same member 20 miles to the southwest, and only 1 thin ash bed is seen near the base of the middle member another 3 miles to the southwest. This distribution suggests a source to the northwest, possibly at or related to the thick sequence of volcanics underlying fossiliferous Silurian rocks at the Mabou Highlands on Cape Breton Island (Phinney 1956, unpubl. S.M. thesis).

The Moydart Formation was deposited as alternating red and green fine grained sediments. The former are considered indicative of at least intermittent subaerial exposure. Fish fossils have been found in these red beds at Arisaig (Ami, 1900). The fact that the Arisaig Series passes quickly and transitionally into these red beds further indicates its shallow water origin.

## Regional

The facies distribution of the Silurian and Devonian rocks in Nova Scotia is shown in figure 17.

In the Arisaig-Northeast Pictou County area are the shallow water beds, discussed above. To the south, these pass through a narrow transitional zone into the sequence present in southeast Pictou County, described above under STRATIGRAPHY. To the southwest, in the Annapolis Valley Bear River areas, the Silurian is represented by a thick succession of graptolitic black shales and minor quartzites. A deeper water origin is usually ascribed to such a graptolite facies. The southeast Pictou County sequence of sandstones, shales, and slates is intermediate between the Arisaig lithology and that of the Annapolis Valley.

Fletcher (1892, p 15) describes a section in the Silurian rocks of the Cobequids as igneous rocks overlain by Medina sandstone, overlain by Clinton black shale, in turn overlain by green sandstones. In his terminology, this could represent either of the stratigraphic sequences observed in Pictou County, but differs from that of the Annapolis Valley.

The various facies are distributed in belts running about east-west, with shallow water beds of a marine shelly facies to the north and deeper water beds of a graptolitic facies to the south. In the Devonian period, the Antigonish and Pictou County areas were the site of intermittently exposed sediments, possibly non-marine, while in the Annapolis Valley a marine shelly facies was being deposited. Thus, the sea retreated to the south at the beginning of the Devonian.