Drumlins

Drumlins are subglacially formed landforms. Their profile often has a steeper, up-ice facing stoss side (with respect to flow) and a more gently sloping, leeved ice side that tails off down-ice (Bennet 1995). This axial characteristic makes them an excellent indicator of flow. The genesis of the Antrim-Charlevoix Drumlin Field began with the ice sheet that deposited the Port Huron moraines at approximately 13,000±150 14C BP (Blewett, 1995). During the advance of this ice sheet, large amounts of subglacial till were also deposited in the areas proximal to the ice margin (Blewett 1995). However, there must be a considerable amount of debris to act as an interface between the glacier and the landscape below it (Menzies 1979). Basal till laid down during the Port Huron advance provided the large amounts of debris needed to form drumlins. Drumlins are broad highlands with high relief, about 205–225 meters in elevation, peaking around 270 meters at the tops of drumlins (Schaetzl 2013). The uplands are composed of glacial drift deposited as till plains during the Quaternary period. Drumlins within both sub-regions of the Antrim-Charlevoix Drumlin Field occur mainly on the upland areas and decrease in frequency as you move inland. Northwest-to-southeast oriented linear valleys are skewed to the right, and the valley channels are the result of meltwater drainage of glacial drift beneath stagnant ice following the Port Huron advance (Blewett 1995). Elongate lakes intersect the uplands in the same fashion as the valley channels and are also the result of meltwater erosion. In some cases these lakes were eroded entirely through the drift to bedrock (Blewett 1995). The drumlins within the Antrim-Charlevoix Drumlin Fields are composed of sandy and loamy glacial drift which leads to soils that are well drained. The parent material is calcareous due to the abundance of calcium carbonate bearing rocks brought south as the ice advanced (Schaetzl 1998). The valleys between the drumlins are composed of poorly drained organic materials up to 1.25 meters thick. The Antrim-Charlevoix drumlins trend azimuthally 338° (mean value), whereas the Leelanau drumlins trend 346° (Lefver 2008). This suggests that the drumlins were formed by a radially spreading glacial margin. The orientation of the drumlins reflects erosion and axial lengthening in the direction of ice flow. The mean drumlin length on the Leelanau Peninsula is 642 meters while the mean length in the Antrim-Charlevoix region is 777 meters. The distribution of drumlin lengths within the Antrim-Charlevoix region display a curve that is skewed to the right, suggesting that the longer section of ice margin over the Antrim-Charlevoix region would have displayed more variability in dispersion, and therefore more variability in crevasse lengths, which would have affected drumlin lengths.

Conclusions

Of the processes overviewed in Menzies’ 1979 synthesis of drumlin formation, the most appropriate theory for the formation of the Antrim-Charlevoix drumlin field would be the “tilt-squeeze” theory. According to this theory, if a subglacial cavity is formed it will subsequently be filled by the underlying till due to a difference in pressure (Menzies 1979). This can be observed directly in small drumlins formed on the lee side of large boulders or rock knobs, causing an obstruction to ice flow. However, it is unlikely that any single boulder could initiate the amalgamation of till on the scale of the drumlins within the Antrim-Charlevoix drumlin field. Instead, I would like to point out that the difference in azimuthal trend of the drumlins (Lefver 2008), suggests that radial dispersion was occurring within the ice. As it radially disperses it begins to generate longitudinal subglacial crevasses (Menzies 1979). Due to differences in pressure within the cavity of the crevasses and at the basal ice contact, till would be forced into the cavity to reach an equilibrium basal pressure (Menzies 1979). Following the initial formation of the drumlins, and the retreat of the Port Huron ice sheet, another ice sheet advanced over the region, during what is now referred to as the Greatlakean ice advance (Schaetzl 2001). This ice sheet advanced relatively fast in comparison to the Port Huron advance. The two advances have been differentiated mainly by carbon dates of the Chicobgan bryophyte bed, which were dated between 11,400 and 12,100 14C BP (Schaetzl 2001). The shallow cover of red colored till could be associated with Greatlakean advance (Schaetzl 2001). I suggest that the red clay layer indicates that the Laurentide ice sheet had a wetter basal interface during the Greatlakean advance than during the Port Huron advance. This would have allowed for relatively fast advance with little deformation to the drumlins that were formed by the Port Huron advance.