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Some Notes on the Glacial Geology of Drake Quadrangle, North Dakota

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Introduction

The Drake quadrangle includes approximately 200 square miles, and lies between 100°15′ and 100°30′ West longitude and between 47°45′ and 48°00′ North latitude. In general, the area is located in the north central part of North Dakota.

This quadrangle is unique in that many ice-contact features are present within the area. These include kames, eskers, and crevasse fillings. It is not the intent of this paper to discuss every ice-contact feature present, but to bring forth the available data gathered by the writer concerning eskers and crevasse fillings, evaluate this information, and try to draw a conclusion as to the probable mode of origin of these features. It is also the writer's hope that some material included in this report may serve as a means for distinguishing these two types of ice-contact features from one another.

Eskers and Crevasse Fillings

Eskers and Esker Areas

There are two main areas containing eskers, in which the individual eskers are so related to adjacent surfaces as to constitute two unities. One esker area is located in the Spring Grove Township and another is located in Rosenfield and Georgetown Townships.

The esker area, located in Rosenfield and Georgetown Townships, contains one distinct esker trending generally northwest-southeast. It is a gentle hummocky, steep sided, sinuous ridge of dominantly water sorted drift. It is approximately 3 miles in length, 50 to 75 feet in width, and ranges between 30 and 60 feet in height. The esker disappears in outwash of approximately the same elevation to the south. This esker is associated with complexes of small knolls, ridges, and closed depressions. It is also quite important to note that all of these features occur on low ground in a distinct valley.

The eskers occurring in the Spring Grove Township area are complex, reticulated and branching. These eskers have gentler side slopes than the esker described previously. They vary from ½ mile to 2 miles in length, from 20 to 40 feet in height, and from 50 to 75 feet in width. The short branches are only 10 to 15 feet

high and 30 to 40 feet wide. Among the eskers are troughs a few rods wide corresponding to the "esker troughs" described by Thwaites (1946).

The internal structure and composition of all of the eskers is essentially the same. It is accessible for study in numerous gravel pits. The material ranges from silt size to boulders 4 feet in diameter. The boulders, which are not plentiful, occur along the crests of the eskers. The bedding is very irregular and discontinuous. Transverse sections present a pseudo-anticlinal structure, while a longitudinal section shows a fore-set bedding structure. The angle of repose of the sediments is approximately 30° varying with the size grade of the material, while the fore-set bedding dips approximately 10°. Cross-bedding is encountered in the finer material of silt and fine sand size along the crests of the eskers. Local coverings of till are also present.

The dominantly subangular shape of the pebbles and the composition of the stratified drift indicates that the material is of local origin and that it has not been transported far by fluvial action. Sorting is good making eskers an excellent source of gravel.

It appears from the study of the eskers in the Drake quadrangle that they were formed subglacially. Melt-water, which reached the base of the glacier through moulins and cracks, was concentrated in channels of pre-glacial or subglacial origin. In the writer's opinion, the initial phase of the esker formation was the deposition of material at the reentrant of a subglacial channel. The sudden drop of competency of the melt-water at the reentrant caused deposition of material. This material acted as a dam partially ponding some of the melt-water subglacially causing further deposition. This process continued building the esker headward. The esker troughs were formed by drainage of melt-water around the eskers. The belief that the initial phase of esker formation occurs at the reentrant is based upon the association of the outwash with the down stream end of the eskers. Local coverings of till on the top and sides of the eskers and the few boulders scattered along the ridge support the subglacial theory. This material is probably ablation drift let down upon wasting away of the ice.

Crevasse Fillings

Excellent examples of crevasse fillings occur in the NW$\frac{1}{4}$ of the Drake quadrangle. They are straight, level-topped ridges of approximately 10 to 15 feet high, 40 to 45 feet wide, and from half a mile to 1 mile long. The crevasse fillings trend approximately north-

west-southeast, paralleling one another, and have an appearance much like a railroad grade.

One small abandoned gravel pit was found in a crevasse filling. The lack of gravel pits suggests that the material contained in these features is not as well sorted or stratified as the material contained in eskers or kames which are producers of much gravel. The description of the material and structure present in these features was obtained from a road cut. This exposure shows the crevasse filling to be in general poorly sorted, and irregularly bedded with abrupt changes from one grade to another. The upper few feet of this road cut displays material which is dominantly a fine sand and silt containing pebbles, and also pockets and lenses of coarse sand and gravel. Some till is present about the borders of the fillings, but it is very localized in distribution. As in eskers, a pseudo-anticlinal structure is present in a transverse section, and fore-set beds are apparent in longitudinal section. The dip is very slight and in some places the bedding is nearly horizontal.

Many geologists have confused eskers and crevasse fillings because of the common factor that both were deposited by streams between ice walls. Much disagreement has arisen as to (a) the position of the stream which deposited the material, and (b) the state or condition of the ice at the time of deposition. One hypothesis as to the formation of crevasse fillings is that englacial streams deposited debris in open fractures on a floor of ice. Subsequently the ice melted gradually letting the deposit down to the ground. It is difficult to conclude that many crevasse fillings have this mode of origin. If this were true, crevasse fillings would not maintain their very characteristic topographic form, and the sediments would be deformed. Also, it is likely that the part of the ice protected by the sediment would not melt as fast as the exposed ice, thus removing the ice-contact responsible for the forming of such features before the crevasse fillings could be deposited on the ground. A subglacial stream might in part of its course flow in open crevasses, and in such a case deposition would take place directly upon the ground. Ponding of water within the crevasses would account for the level-top, and sluggish drainage from the crevasses would account for the poor sorting.

Conclusion

From the discussion which preceded, it appears that certain definite characteristics may be attributed to the eskers and crevasse fillings of the Drake quadrangle. These characteristics are as follows:

Eskers

1. They occur in definite channels of pre-glacial or subglacial origin.
2. They are definitely associated with complexes of small knolls, ridges, and closed depressions as well as to outwash into which some of the eskers disappear.
3. They are gentle hummocky, sinuous, and steep sided ridges.
4. "Esker troughs" are located among the eskers.
5. A tributary and distributary pattern is commonly present.
6. The material, making up the internal structure of an esker, is derived from a local source.
7. The material is predominantly coarse, but ranges from silt to boulder size; local coverings of till are also present.
8. Boulders generally occur along the tip and sides of an esker.
9. The bedding is irregular, and sorting is rather good.
10. Transverse sections through eskers display a pseudo-anticlinal structure. Longitudinal sections display a fore-set bedding structure.

Crevasse Fillings

1. They have no definite relationship to prevailing topography.
2. They may trend in any direction with no respect to direction of ice movement, but in the Drake quadrangle the crevasse fillings parallel the trend of the eskers and therefore the direction of ice movement.
3. They are straight, level-topped ridges.
4. Sorting is poor and the material may be coarse or fine. It is not uncommon to encounter fine sand or argillaceous sand lenses. Local coverings of till may be present.
5. The pseudo-anticlinal and fore-set bedding structures are present as in eskers, but the bedding in many places is nearly horizontal.

Summary

In summary, it might be well to list certain definite characteristics which were used to distinguish eskers and crevasse fillings from one another in the Drake quadrangle:

1. Eskers sinuous ridges vs. crevasse fillings straight ridges.
2. Eskers hummocky crests vs. crevasse filling level-topped crests.
3. Eskers good sorting vs. crevasse fillings poor sorting.
4. Eskers tributary and distributary pattern vs. crevasse fillings not possessing any such pattern.

Literature Cited

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