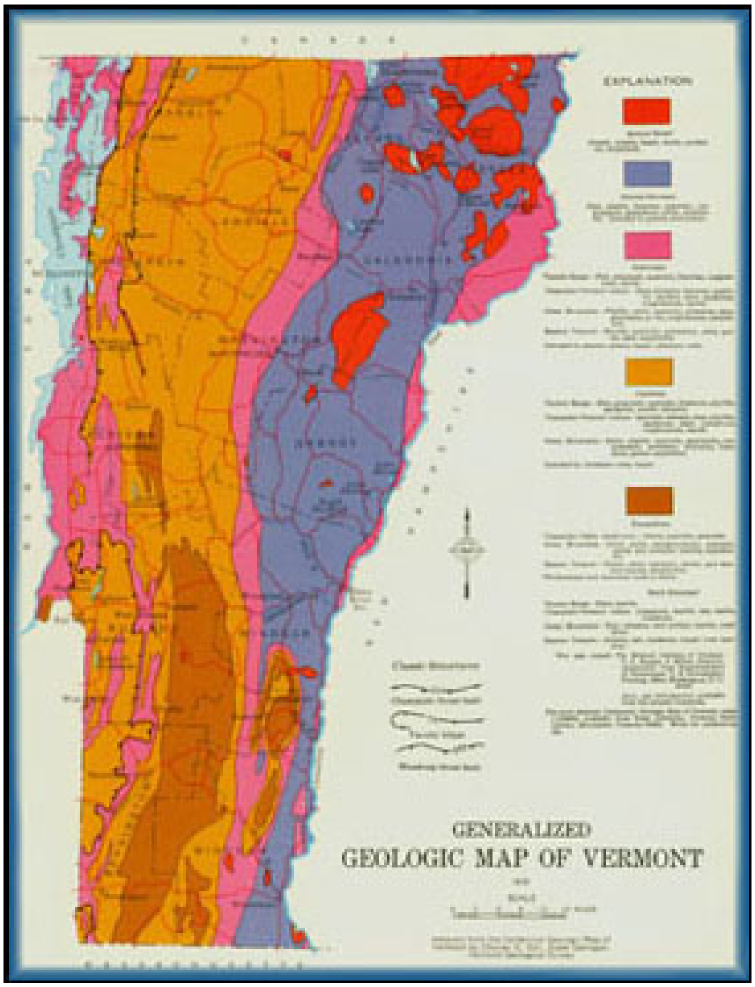
Vermont Stream Geomorphic Assessment

Appendix F



Geologic Information

Vermont Agency of Natural Resources
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Geologic Information

Common Geologic Materials Found in Vermont

Alluvium (river sediments):
Alluvium is sediment deposited by a stream. It may consist of boulders, cobbles, gravel, sand, or silt. Alluvial deposits may be modern or ancient, although all of the alluvial deposits in Vermont post-date the last glaciation. These are the materials that are called postglacial fluvial deposits on the *Surficial Geologic Map of Vermont* (Doll, 1970). Modern deposits are found in active stream channels and in floodplains, and they may also occupy low terraces which are occasionally flooded during high flows. If a stream has been incising down into a valley, old alluvial deposits may be evident in the recently abandoned floodplain, out of reach of current flood levels. Alluvium deposited in floodplains is typically fine sand or silt. On steep streams the cobble and boulder alluvial deposits are typically imbricated, that is they are stacked like dominoes leaning upstream.

Figure F-1: Imbricated alluvium

Ice-contact Deposits:
Ice-contact deposits are composed of sediments which accumulated in lakes, ponds, or streams in contact with glacial ice. Ice-contact deposits are associated with the landforms known as kames, kame terraces, and eskers. In contrast to glacial till, ice-contact deposits show evidence of sorting and layering due to the action of flowing water. The grain size of the material can range from silt and clay up to cobbles and boulders, although most of the material is usually of sand-size or coarser. When we look at these deposits today, the layers of sediment are commonly folded or faulted because they were deposited on or next to blocks of stagnant glacial ice, which subsequently melted away, causing the sediment deposits to collapse.

A kame is a small, isolated hill of stratified sand or gravel. Kames form as streams deposits sand and gravel in depressions on the ice surface. When the ice melts away, the collapsed remnant of the deposit is left standing alone as a small, lumpy hill.

A kame terrace is similar to a kame in that it is a stratified deposit composed mostly of sand and gravel. However, the kame terrace is typically a long terrace on the edge of a valley, formed between the stagnant remnant of a glacier in the valley and the valley side. Streams wash material off of the glacier and the hills into an ice-marginal lake. In some deposits, considerable amounts of silt or clay may be included. When the ice melts away, a terrace consisting of collapsed, stratified material is left behind.

An esker is a long, narrow, often winding ridge composed of water-lain deposits of sand, gravel, and boulders which formed as a stream deposit in a tunnel within or at the base of a retreating glacier. When the glacier melts away, the snake-like ridge remains behind. These ice-contact fluvial deposits are also known as glaciofluvial deposits. The coarse cobble and boulder deposits which are often seen in eskers formed as point bar and channel deposits and are indicators of the tremendous volumes of water which once flowed through these glacial meltwater streams.

Glacial Lake Deposits (Glacio-lacustrine):
As the ice melted back northward at the close of the last glaciation lakes formed in many of the valleys in Vermont. Glacial meltwater and runoff from the surrounding hills poured into these lakes. Deltas of sand and gravel formed where streams entered the lakes and beach deposits of sand and gravel formed along the shorelines. Out in the deeper waters of these lakes fine sand, silt, and silty clay accumulated. The fine-grained deposits often have layers called varves. Varves are annual layers of fine-grained sediment deposited into lakes in the vicinity of glacial ice. One pair of light and dark layers forms over the course of each year, the light layer being a relatively coarser-grained warm season deposit and the dark layer being a relatively finer-grained winter deposit.

Glacial Marine Deposits (Glacio-marine):
After glacial ice melted out of the St. Lawrence River valley an arm of the Atlantic Ocean extended up into the Champlain valley to form the Champlain Sea. The deposits consist of beach gravels and sands that formed on the margins of the sea and fine-grained deposits that formed in deeper waters. The fine-grained material is typically a sticky, dark-gray silty clay although it is sometimes varved. Fossil marine shells are locally common.

Till:
The most widespread surficial deposit in Vermont is glacial till. As the glacial ice flowed over Vermont, it scraped up everything in its path. As the ice melted back, tremendous quantities of sediment were produced, some of which washed away with the rushing melt-waters and some of which was left behind. The material that was left behind is glacial till. It contains a mix of grain sizes, from tiny clay-sized particles up to huge boulders. In Vermont, glacial till has been crudely divided into two classes, basal till and ablation till. Basal till is perhaps more accurately called lodgement till, as it appears to be material that has been lodged or plastered under the ice as the glacier flowed over it. This material has enough silt and/or clay in its matrix so that it is very compact and firm. When it is freshly exposed, lodgement till is so firm that it is difficult to dig up, even with a pick, thus leading to the name “hardpan”. Ablation till also contains a wide variety of grain sizes, but it is much sandier and looser than lodgement till. It seems to have pretty much dropped out in place as the ice wasted away. It is thought that most of the silt and clay in the ice washed away as the ice melted, leaving behind a till with a sandy matrix. Ablation till is far more

erodible than unweathered lodgement till, although if stream flows are high enough, serious erosion can also occur in lodgement till.

Colluvium:
Colluvium is material that accumulates at the base of a slope as the result of gravity or sheet-flow (runoff from the land which has not been concentrated into channels). The term includes rockfall deposits that accumulate beneath steep rock faces (talus), as well as landslide, slump, and debris flow deposits formed from any of the surficial materials described above. Thus, if a slump occurs in a steep bank of lodgement till, then the material in the slide is considered to be colluvium.

Bedrock:
The most stable streams are those with bedrock beds and banks. In areas where streams are cutting through bedrock, the rates of bank and bed erosion are much lower than in areas where none is exposed. Although streams have the power to dramatically erode even the hardest bedrock over centuries or millennia, bedrock in stream beds and banks is not usually severely eroded over the course of a few years or decades. Thus, waterfalls, cascades, and ledges in rivers provide relatively permanent controls on the grade (elevation) of rivers. Where bedrock is not exposed in the bottom of a stream valley, the stream may cut down into the surficial materials dramatically, particularly if the equilibrium of the stream is disturbed. Although bedrock outcrops in a bank or bed usually contribute to the stability of the stream, a ledge on one bank may deflect stream flow against the opposite bank downstream, leading to increased erosion.

Bedrock also is the source of the material found in the surficial deposits such as till and alluvium. Different bedrock types have different qualities. For example, granites are low in calcium and do not contain biological material. Rivers that drain from granitic bedrock are usually not highly productive in terms of aquatic habitat. On the other hand, marbles and dolomites are common in the Champlain Valley, and throughout much of Central Vermont. Rocks of the Waits River and Gile Mountain Formations are formed from sediments deposited in a tropical ocean. There was a lot of biological activity in these warm oceans, and the rocks contain a lot of calcium. This calcium is an important nutrient, and it also keeps the pH (a measure of acidity) higher in the streams, thus buffering the affects of acid rain. Streams draining through this kind of bedrock often have high biological productivity, supporting large and healthy populations of aquatic insects, amphibians, and fish.

Where To Find Geologic Information

There are several sources for geologic information about Vermont watersheds, notably the publications of the Vermont Geological Survey (VGS), the U.S. Geological Survey (USGS), and the Natural Resources Conservation Service (NRCS).

The VGS has a variety of information about the bedrock geology and surficial geology of the state. Besides the statewide maps of the bedrock and surficial deposits (Doll and others, 1961; Doll, 1970), detailed bedrock geologic maps are available for most of the state at either 1:62,500 or 1:24,000 scale. The 1961 bedrock geologic map is now out of print, but scanned images of the map are available from the Survey on CD-ROM and a new edition is in preparation by the VGS and the USGS. Scanned images of the 1:62,500 scale maps used to compile the 1970 surficial geologic map are available from the VGS and several areas have recently been remapped. Bulletin 31 (Stewart and MacClintock, 1969) provides descriptions of the surficial materials in the state. A series of environmental geology reports covers much of the state. These reports include information on surficial and bedrock geology, groundwater potential, and cross sections that show the thickness of surficial deposits. For more information on these and other publications contact the VGS at 103 South Main St., Laundry Building, Waterbury, VT 05671-0301, phone (802) 241-3608, web site <http://www.anr.state.vt.us/geology/vgshmpg.htm>. A publication list is available both in printed form and on the web site.

The USGS also has many publications dealing with Vermont geology. Check for publications related to water resources at the web site of the New Hampshire-Vermont USGS Office at <http://bowdnhbow.er.usgs.gov/ >. These include a series of bridge scour studies performed for the Vermont Agency of Transportation. The USGS also maintains a search engine for its publications at <http://usgs-georef.cos.com/>. The VGS can also help direct researchers to some of the USGS publications.

The Soil Surveys of the NRCS (formerly Soil Conservation Service) contain a wealth of information, including interpretations of the surficial geologic materials. Every soil series (the basic soil subdivision) has been assigned a parent material classification. The parent material is defined by NRCS as "...the unconsolidated material, mineral or organic, from which the soil develops" (Natural Resources Conservation Service, 1999, Part 618.40). In Vermont the parent materials are broadly broken down into six categories: alluvial, glaciolacustrine, glaciofluvial, glacial till, dense till, and organic deposits. The glaciolacustrine category includes glacial lake deposits as well as marine deposits from the Champlain Sea. The glacial till listing appears to include some materials which geologists would classify as ablation till and some which may correspond with weathered basal till. The dense till corresponds with basal till.

Because soils are classified based on the characteristics of the materials encountered in the first 60 inches in depth, soil maps do not always accurately portray the dominant parent material at a site. For example, if a hole is augured down into a flat terrace and passes through six feet of recent stream alluvium overlying 20 feet of lacustrine silt and silty clay, then the soil would be mapped as one which has an alluvial parent material. The lacustrine material would only show up on a soil map if erosion has exposed a considerable thickness of it on a steep slope below the terrace. The soil surveys are thus best at portraying the materials at the surface and do not fully show the three-dimensional nature of the deposits.

References

1. Doll, C.G., W.M. Cady, J.B. Thompson Jr., and M.P. Billings. 1961. Centennial geologic map of Vermont: Vermont Geological Survey, 1:250,000.

2. Doll, C.G. 1970. Surficial geologic map of Vermont: Vermont Geological Survey, 1:250,000.

3. Natural Resources Conservation Service. 1999. National Soil Survey Handbook: online at <http://www.statlab.iastate.edu/soils/nssh/>.

4. Stewart, D.P. and Paul MacClintock. 1969. The surficial geology and Pleistocene history of Vermont: Vermont Geological Survey, Bulletin 31, Montpelier, 251p.