

VERMONT

Vermont Geological Survey
1 National Life Drive, Main 2
Montpelier, VT 05602-3902
Marjorie H. Gale
State Geologist and Director
<http://dec.vermont.gov/geological-survey>
Marjorie.gale@vermont.gov
Phone: (802) 522-5210

INTRODUCTION

The VGS, a Division in the Department of Environmental Conservation (DEC) in the Agency of Natural Resources, is guided by the Department mission to protect human health and safety. Our services, research, publications and educational outreach provide basic geologic information and emphasize the application of geology to issues of health, hazards and groundwater resources. Activities are guided by statute that designates the State Geologist as the Director of the Division of Geology and Mineral Resources. Statutory activities include providing aid and advice, providing geologic expertise to regulatory programs, conducting research related to geology and mineral resources, and publishing and disseminating geologic reports. Geologic research and mapping are used to address critical issues in Vermont.

GROUNDWATER AND HEALTH

The VGS and our partners develop geologic data and information for the public to inform decisions about groundwater use and protection related to public health concerns (arsenic, radioactivity, asbestos, radon, nitrates). Aquifer characterization studies have been conducted by town and by region. For example, arsenic levels above health-based standards in drinking water supplies were investigated by integrating mapping with water and bedrock geochemistry.

PFOA Project

Based on expertise developed in studies of naturally-occurring contamination, the VGS was asked to conduct a geologic and geochemical study of PFOA contamination of fractured bedrock in southern Vermont. Jon Kim (VGS) is leading the aquifer characterization project to map bedrock and structure, review water well logs, log selected wells in partnership with SUNY Plattsburgh, photograph and describe cores that were drilled on the Chemfab property, and map surficial deposits in coordination with DeSimone Geoscience. Middlebury College has also partnered with the VGS to collect and analyze water chemistry data. The USGS is conducting

an isotopic age study based on analyses of 5-8 wells. The integrated data will give a 3-dimensional view of the subsurface in the plant vicinity and be used to interpret groundwater flow. The study has implications for future mitigation in the area.



Figure 1. Water sampling at a spring in North Bennington

Nitrates Project

In 2015-2016, the VGS and colleagues from the Vermont Agency of Agriculture and Middlebury College concluded a 10-year study of point and non-point source nitrate contamination of bedrock wells near a dairy farm in East Montpelier and the subsequent recovery of those wells. Their work showed that zones in the bedrock aquifer responded differently to both contamination and remediation during the 10-year time frame and it documented the physical and chemical methodologies and data needed to characterize a bedrock aquifer and groundwater chemistry in deformed metamorphic rocks. The data and methods defined potential flow paths, rates of groundwater flow in various directions, connectivity of wells to fractures, and potential mineral chemistry effects on the water chemistry. The bedrock aquifer characterization methods established are currently being applied to the evaluation of the PFOA contamination in the bedrock aquifer in North Bennington and a nitrate contamination issue in Sutton.

Reference: Kim, J., Comstock, J., Ryan, P., Heindel, C., and Koenigsberger, S., 2016, Denitification and dilution along fracture flowpaths influence the recovery of a bedrock aquifer from nitrate contamination: Science in the Total Environment 569-570, 450-468, <http://dx.doi.org/10.1016/j.scitotenv.2016.06.091>.

Other Groundwater Programs

The VGS, in coordination with others in DEC, received a US Geological Survey Water Use Data and Research program grant to assess and inventory the current state of water withdrawal and consumptive use data collected in Vermont and to investigate, based on priorities, how to develop collection efforts to produce better baseline

data. The VGS seeks better quality water withdrawal and consumptive use data to apply towards water budget analyses and towards identification of geographic areas in need of detailed groundwater and hydrogeological information.

The Vermont Rural Water Association (VWRA), EPA, Rodney Pingree (Drinking Water and Groundwater Protection Division) and the State Geologist conducted several seminars for groundwater protection and planning groups in Vermont. A case study of a local community "NoWaterTown, Vermont" and basic geology and groundwater information were presented as a framework for planning for future public water supplies, loans and outreach. Kira Jacobs of EPA discussed the Source Protection Collaborative and other Federal partnerships and Liz Royar of Vermont Rural Water Association addressed planning for source protection at the local level. The small focus groups were an ideal forum for productive discussions with planners.

Vermont's Regional Planning Commissions requested our assistance in defining areas at higher risk during drought and in understanding groundwater availability.

MAPPING PROGRAM

Bedrock and surficial maps are used to address Vermont issues such as radioactivity and arsenic in groundwater, groundwater recharge potential and to mitigate landslide hazards. The VGS involves communities at a grassroots level and addresses issues specific to town and state



Figure 2. Sandy till mapped in Woodbury, Vermont.

needs while maintaining the quadrangle mapping structure. This year our town partners provided in-kind match (GIS services and field assistance) for the cooperative

federal STATEMAP program. The funds were further leveraged through student interns who spent time in the field and later completed projects ranging from water chemistry to tectonics. Maps were posted on the VGS web site for easy access for Vermont communities.

The following maps and Open File reports, funded in part by the STATEMAP program, were released in 2016:

Springston, G., Kim, J., Gale, M. and Thomas, E., 2016, Geology and hydrogeology of the Town of Calais, Vermont: VGS Open File Report VG2016-1, 8 color plates, scale 1:24,000.

Springston, George, 2016, Surficial geology and hydrogeology of the Cabot 7 1/2 minute quadrangle, Vermont: Vermont Geological Survey Open File Report VG2016-3, text plus 9 plates and GIS data.

VanHoesen, John, 2016, Surficial geology and hydrogeology of Monkton, Vermont: Vermont Geological Survey Open File Report VG2016, text plus 9 plates and GIS data.

LANDSLIDE HAZARDS

Landslide hazard mapping, first response to landslides, and monitoring of landslide and rockfall sites in order to reduce public exposure to hazards were major activities of this program. Outreach efforts were directed towards regional planning commissions and implementation of landslide mapping protocols. A Phase One landslide hazard map for Addison County, with heavy reliance on Lidar and some field verification, was completed.

A more detailed landslide hazard mapping project in Highgate, funded through the Local Hazard Mitigation Grant Program (LHMPG), was completed in 2016. The findings of the hazard assessment report will be used to identify potential mitigation projects and will be incorporated in the Town's Local Hazard Mitigation Plan (LMHP).

The VGS and our partners also responded to bank failures along several rivers, Lake Champlain and to a train derailment. The National Transportation Safety Board (NTSB) contacted the Geological Survey for geologic assistance at the train derailment site in Northfield, VT in the fall of 2015. The NTSB, an independent US Federal Agency, is charged with determining probable cause(s) of transportation accidents and making safety recommendations.

The following reports were released in 2016:

Springston, G., 2016, Final report on a landslide inventory of the Town of Highgate, Vermont: Vermont Geological Survey Open File Report VG2016-4, text plus 6 plates, scale 24,000.

Van Hoesen and others, 2016, Final Report summarizing the efficacy of GIS-based modeling of landslide susceptibility, Addison County, Vermont: Vermont Geological Survey Technical Report VGTR2016-1.

SEISMIC HAZARDS

The Vermont Division of Emergency Management and Homeland Security (VEMHS) held a statewide emergency exercise, Vigilant Guard, in 2016. The Vigilant Guard exercise included a postulated earthquake(s) which would have significant (devastating) impacts on the State. The State Geologist presented earthquake information to the planning group and highlighted less devastating

but more plausible earthquake scenarios. To meet the needs for this particular exercise, the exercise planners developed a worst-case scenario involving several epicenters in New England and Quebec.

A year-long study was conducted by Northeast States Emergency Consortium (NESEC) in association with the Vermont State Geologist, the Vermont National Guard and the VEMHS. Buildings were rated through ROVER (Rapid Observation of Vulnerability and Estimation of Risk) based on factors such as year built, type of building (unreinforced masonry, steel frame etc), number of occupants, and plan irregularities. The building rating was then applied to estimate damage during a seismic event in HAZUS-MH, a computer program for risk assessment and damage estimates. Based on the report, 85% of the critical facilities screened were recommended for detailed review based on safety ratings. The report is part of our effort to develop technical information applicable to earthquake mitigation in Vermont. Plans were made to develop projects with the UVM College of Engineering service learning class to conduct the on-site assessments of facilities.

PUBLIC OUTREACH

Survey staff is active in education and outreach through school visits, field trips for towns and local officials, lectures, and the web site. Presentations at professional meetings such as the National Groundwater Association and the Northeast Geological Society of America are also important venues for maintaining our geologic expertise and contributing to the science community. We also gave numerous presentations to other government agencies and non-profit organizations including lifelong learning programs, planning commissions, university seminars and classes, conservation groups and a church congregation.