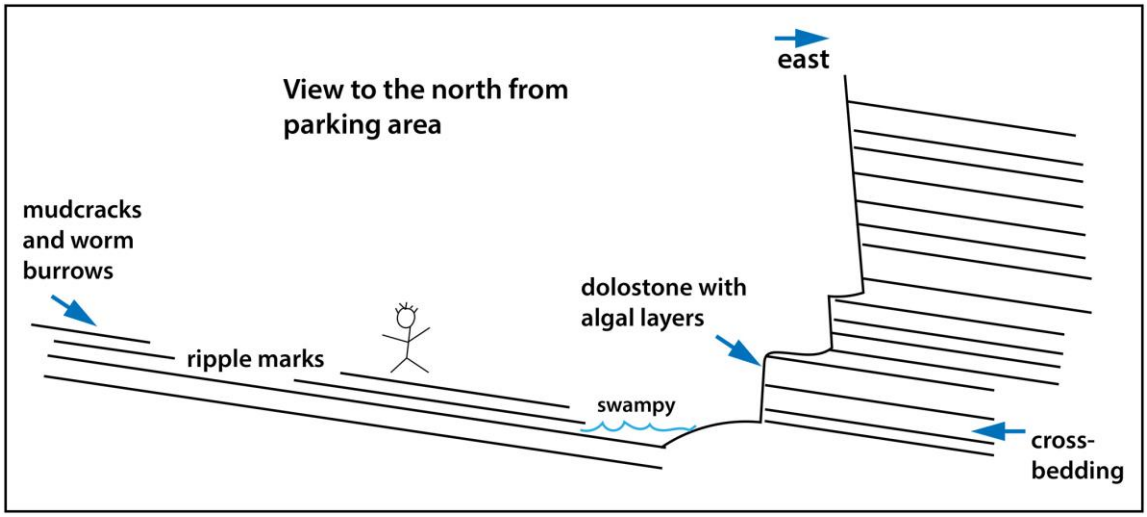
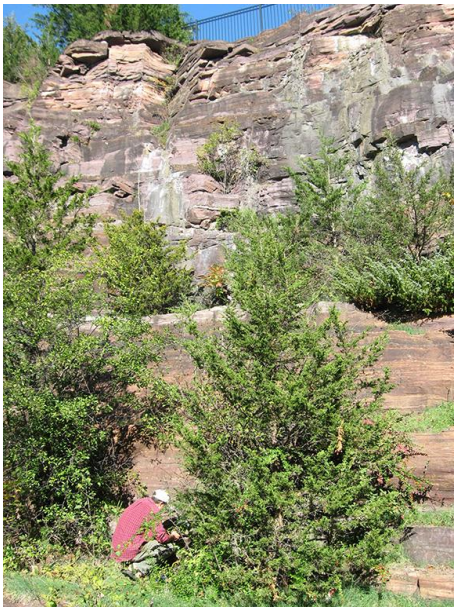
Visitor's guide to the Redstone Quarry

The rock layers at the Redstone Quarry UVM Natural Area record sediment that was deposited on the shoreline of an ancient ocean approximately 540 million years ago. The red-colored sandstone rock unit that is found here at Redstone Quarry and at several other locations around Burlington (ex, Red Rocks Park) is called the *Monkton Formation*. The rocks of the Monkton Formation preserve the sediment, structures formed by extinct marine organisms, and sedimentary structures that formed on the shoreline of an ancient ocean. Evidence for this interpretation can be seen by walking on the rock layers of the Redstone Quarry and looking down at the rocks under your feet. You are literally walking on what was an ancient sea floor.

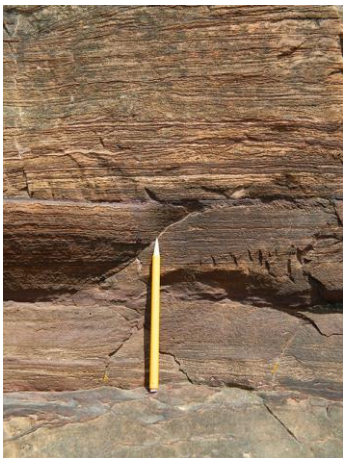




East wall of Redstone Quarry. The orange colored rocks are dolostone and the red to pink colored rocks are sandstones

Most of the rock layers are composed of sand grains compacted and cemented together to form the sedimentary rock termed *sandstone*. There are sand grains of a variety of different sizes in these rock layers, which indicates that the velocity of the moving water varied. The red coloration of the sandstone layers reflects the presence of tiny grains of iron-rich minerals which have rusted (oxidized) and turned red. Another sedimentary rock type present here is buff-colored. Visible in rock layers in the eastern wall of the quarry, this rock is termed *dolostone*. Dolostone is a composed of tiny crystals of the mineral dolomite, which forms in sea water. The interlayering of these two sedimentary rock types tells us that conditions on the Monkton shoreline were continually changing. We believe that sand grains were washed onto the shoreline from storm events and then reworked by waves and tidal currents. During fairweather conditions dolostone formed.

Some dolostone layers contain very thin (millimeter scale) layers of red-colored sand grains. The thin layers are not flat but have a "crinkled" appearance which records the former presence of organic microbial or algal layers that trapped the sand grains. These features are important because they are associated with very shallow water depths where photosynthesizing organisms could flourish.

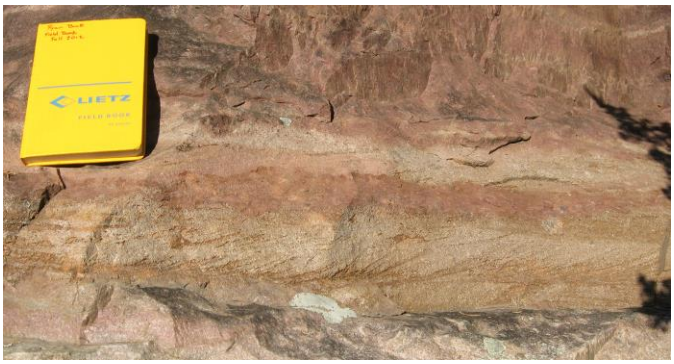


Thin layers of sand in dolostone are formed by the trapping of sand grains by organic material

The ridges that are found on the tops of rock layers are termed *ripple marks*. Ripple marks are produced by the back and forth motion of waves or from currents sweeping along the shoreline.

Different orientations of the crestlines of ripple marks on two sandstone layers, Salmon Hole

The size and spacing of the ripple crestlines indicates that the water was very shallow – probably barely a foot deep. The ripple crestlines are oriented in many different directions, even on the top of the same rock layer, which is a characteristic of the shoreline environment. Larger ripple marks, termed cross-bedding, are visible in side view in some sandstone beds near the base of the east wall of the quarry.



Inclined sand grains are visible in side view through a sandstone bed. This is a structure termed "cross bedding," which form from large ripples

Much less common than ripples are rock layers that contain *mudcracks*, evidence that periodically the sediment was exposed to air, dried out, and cracked.

Mudcracks on the top of a sandstone bed. The cracks have been infilled with dolostone from an overlying layer.

The rock layers also preserve evidence of the movement of trilobites (small ancestors of horseshoe crabs) and worms through the sediment. Trilobite fossils have never been found at Redstone Quarry but they have been noted in exposures of the Monkton Formation elsewhere.

Worm burrows visible on the surface of a sandstone layer, Redstone Quarry.

The sandstones and dolostones of the Monkton Formation are not the only rock type that can be seen at Redstone Quarry. At the base of the north side quarry wall is a vertical layer of black rock. This is an igneous rock termed *basalt*. Note that the basalt cuts through, or intrudes through, the layers of red rock. When an igneous rock layer cuts vertically through surrounding rock layers we call it an igneous dike. This dike, and others like it in the Champlain Valley, have been dated to around 65 million years ago. It represents magma from within the earth that rose towards the surface, cutting through older rock layers along the way. The intrusion of magma in the Champlain Valley and southern Quebec is related to the tectonic events accompanying the opening of the Atlantic Ocean to the east. Because the dike cuts vertically through

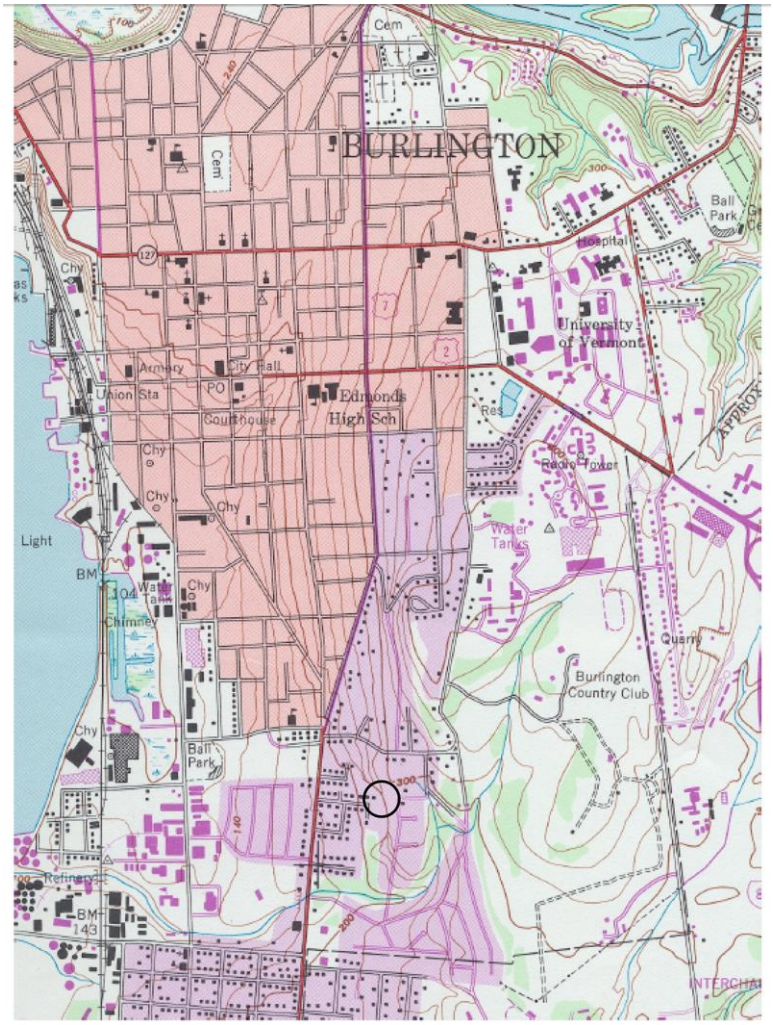
the Monkton Formation we know it must be younger than the Monkton rock layers. When a sequence of rock layers are cut by an intrusion, the rock layers must be older than the intrusion that cuts them, a concept termed the "law of cross-cutting."

The igneous intrusion is the dark grey vertically oriented rock that cuts through the horizontally layered red sedimentary rock

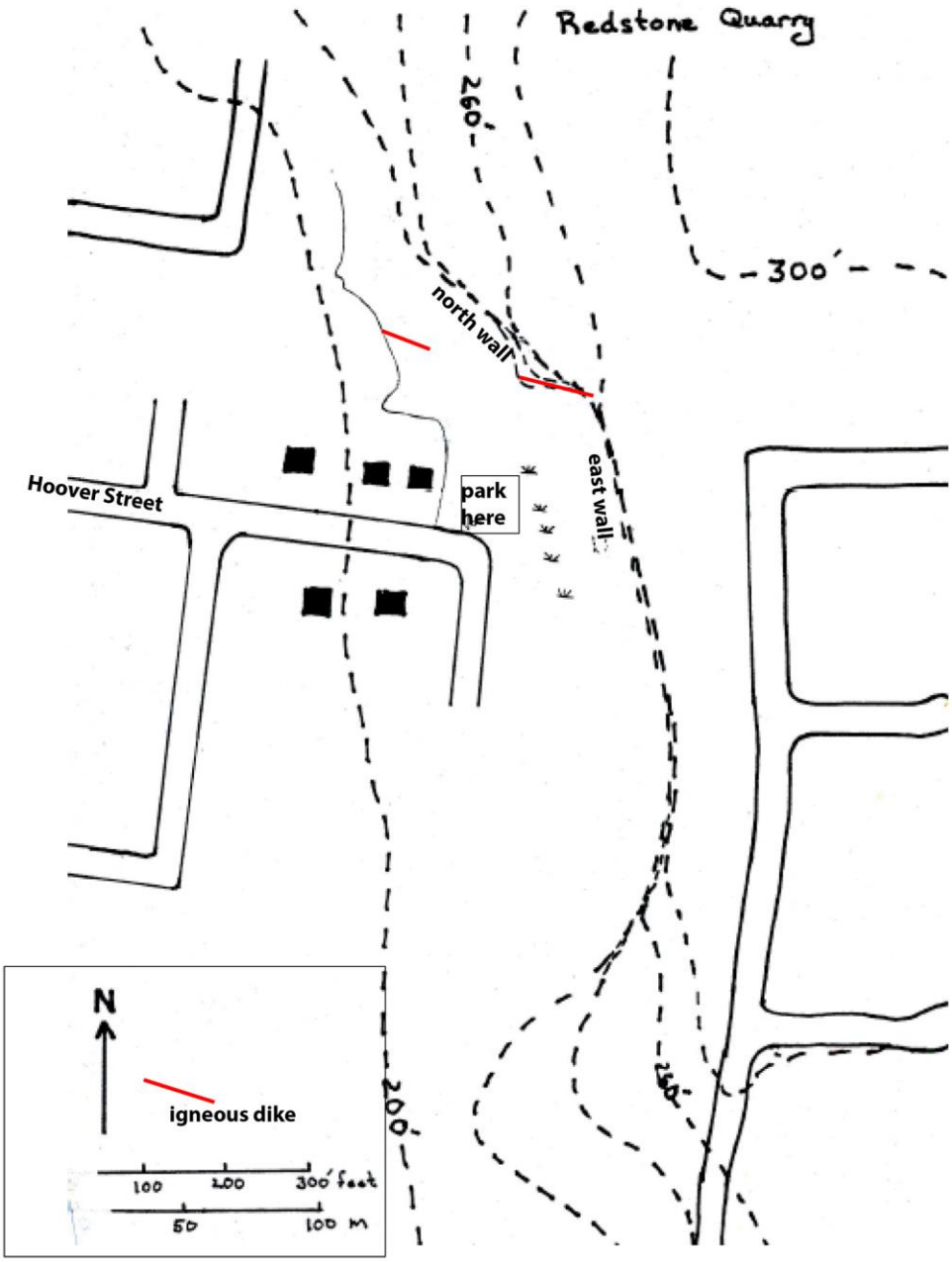
As you were walking around on the rock layers you might have noticed circular holes on some surfaces, surrounded by a radial series of fractures. Because Redstone Quarry was once active these features are the record of drilling and blasting that broke the strata into blocks useful for building.

Redstone Quarry is a famous geology site visited by many professional geologists and school groups. It is a UVM Natural Area and taking samples is prohibited. Please leave the site intact for future visitors. Please respect the private property that surrounds the quarry. Do not deface the rock layers with either paint or scratches.

Map 1: excerpt from U.S. Geological Survey 7.5" topographic map of the Burlington Quadrangle. The black circle is the Redstone Quarry location at the top of Hoover Street.



Map 2: detailed map of Redstone Quarry showing the location of the igneous dike. Between the parking area and the north wall is a broad surface with many ripple marks exposed. The quarry walls to the north and east provide the opportunity to examine the sedimentary rock layers in side view.



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November, 2019
University groups visiting the Salmon Hole can contact charlotte.mehrtens@uvm.edu for more technical information on the Monkton Formation.