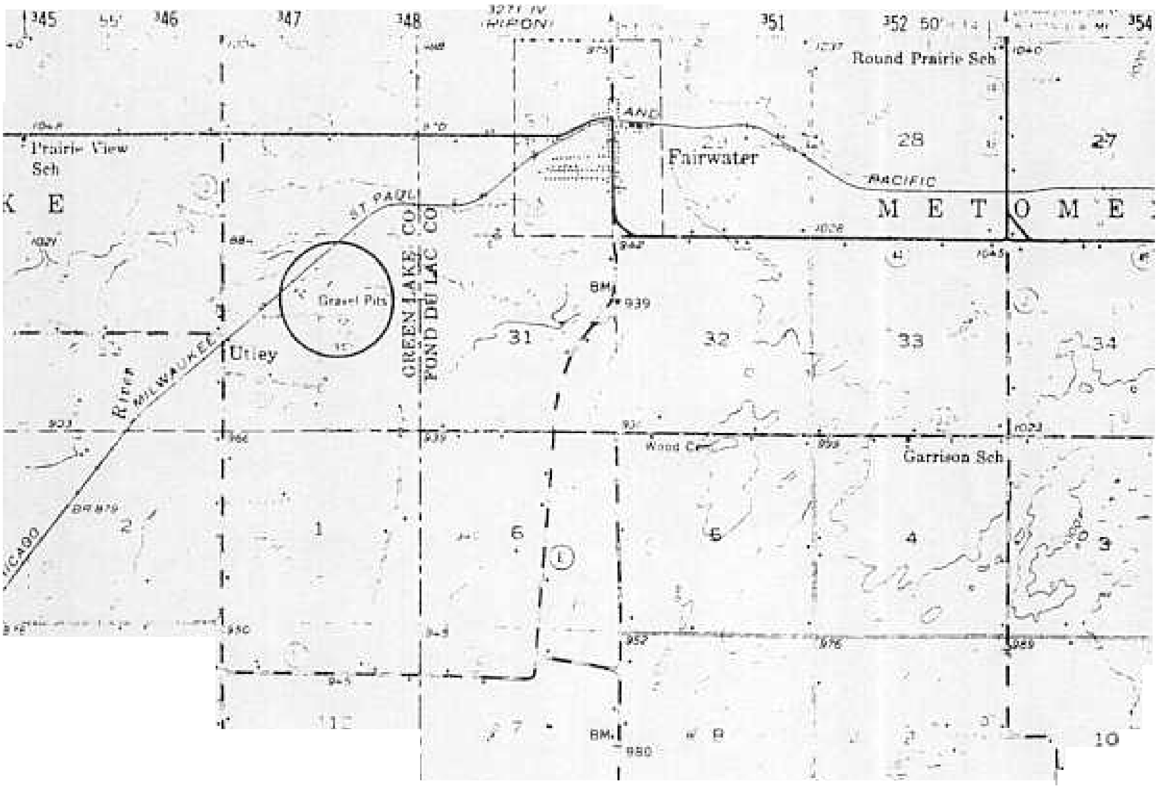
Title: The Utley Rhyolite

Location: NW¼, SW¼, NE¼, Sec. 36, T.14N., R.13E. (Fox Lake 15 Min. Quad.) Green Lake County. Get permission from Lester Schwartz, Art Dept., Ripon College, Ripon, Wisconsin. Phone: 748-8106.



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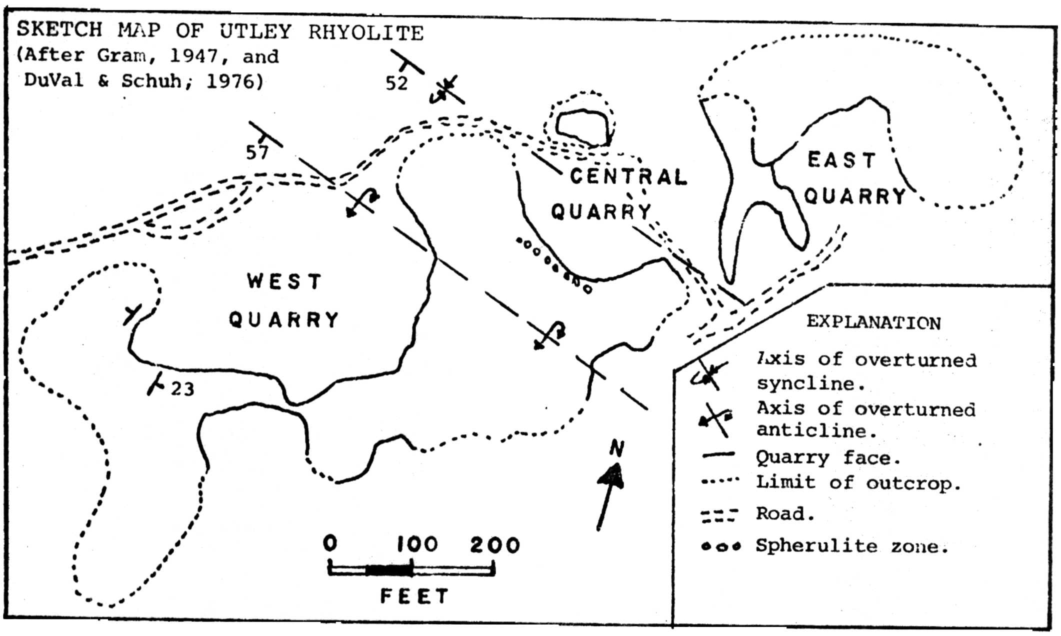
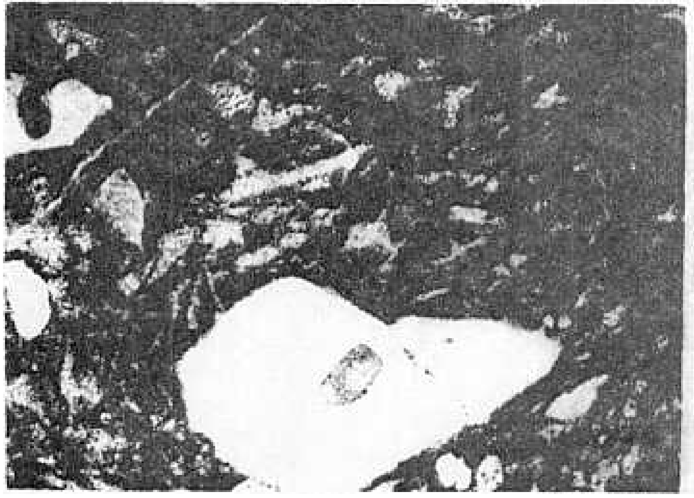
Description: The Utley Rhyolite is one of ten isolated knobs of Precambrian igneous rocks (mainly rhyolites) that protrude through the Paleozoic cover in southeastern Wisconsin. The inliers extend from Berlin southwestward to the Baraboo area. The rhyolites stood as prominent hills on the Precambrian surface, and were rocky islands in the lower Paleozoic seas for nearly a hundred million years. The Utley rhyolite was largely (or entirely) buried by the Prairie du Chien Dolomite, but was partially exhumed during the erosion during a regression of the Middle Ordovician sea shortly thereafter. The advance of the sea over this unconformity resulted in the deposition of St. Peter sandstone in a channel cut into the Prairie du Chien. The large sand quarry just east of the rhyolite is in this channel filling of St. Peter sandstone. The rhyolite was buried again by the St. Peter and Platteville Dolomites and is being exhumed again by erosion.

The dark color of the Utley Rhyolite is typical of most Precambrian rhyolites in Wisconsin. Quartz and feldspar phenocrysts are abundant and present in about equal amounts. The matrix is an aphanitic mixture of quartz and feldspar. Weidman (1898) interpreted this rock as a meta-rhyolite, Gram (1952) interpreted it as a tuff and Asquith (1964) interpreted it as a welded tuff. Smith (1974, 1975, in press) has shown that the various rhyolites in southern Wisconsin formed from ash-flow deposits and chemically are genetically related. Fragmental texture is visible on the weathered surface at a number of places in the quarry. A distinctive zone of "spherulites" on the top of the west wall of the central quarry (see map) trends northwesterly. Gram (1947) concluded that the structure in the quarry consists of a northwesterly trending anticline and syncline. However, the structure has not been worked out in detail, and may be more complex. The rhyolites here illustrate well the problems of mapping structures in Precambrian volcanic rocks. Can you recognize any distinctive zones or features that show the structure?

Microscopically, the rhyolites here show remarkably well preserved shard structures (see photos), some of which are deformed (flattened), others are not. The deformed shards indicate that these are welded tuffs. Many of the quartz phenocrysts are embayed, indicating that the crystals were beginning to melt as a result of changing conditions in the magma (mainly a loss of volatiles) during and after extrusion. The abundance of shards and broken phenocrysts attests to the violent eruption that formed the deposit.





Undeformed shard fragments (white) with quartz phenocryst in rhyolite tuff from Utley. x25.

Flattened shards and broken phenocrysts in welded tuff from Utley. x25.

Significance: The rocks at Utley and other localities in south central Wisconsin are welded tuffs that formed as a result of extremely violent eruptions common to rhyolitic volcanoes. The resulting ash-flow deposits are widespread deposits. The following summary is summarized, in part, from the U.S. Geological Survey Atlas of Volcanic Phenomena (1971). A mass of granitic magma forms near the base of the crust, perhaps 30 miles deep in the earth. The magma contains up to 10% volatiles, mainly water vapor dissolved in the magma. The magma is lighter than the surrounding rocks and rises slowly through the crust. As it approaches the earth's surface, the area above the rising magma is domed, and circular to elliptical fractures are formed. The central area subsides somewhat on the ring of fractures. Some of the magma escapes to the surface along the ring of fractures, building a series of small andesitic and rhyolitic cones.

The rising magma eventually reaches a level in the crust where the pressure of the dissolved gases exceeds that of the overlying rocks. The result is a violent expansion of the gas, frothing and fragmenting the magma, and driving it upward to the surface where it bursts forth along the circular fractures as a seething mixture of gas-charged dust, ash and pumice. This exceptionally fluid gas-solid mixture expands with hurricane force, streams down valleys and around hills, spreads out over low areas, and comes to rest as a great sheet of steaming ash-flow tuff. Repeated eruptions, adding sheet upon sheet of tuff, build an ash-flow field hundreds to thousands of feet thick that covers several thousand square miles.

As the upper part of the magma chamber is drained by the eruptions, the crust in the central part of the area collapses to create a huge circular depression called a caldera. Following the collapse some ash is ejected along the ring fractures to form ash cones. The final phase is the eruption of viscous rhyolite, largely depleted of gas, as a series of domes or spires.

The violence of the eruption is so great and the volcanic materials are so hot that many of the glassy volcanic fragments are still soft when the ash-flow sheet comes to rest. The fragments are commonly flattened and may partially melt ("weld") together to form very hard rocks called welded tuffs. Commonly, the bottom of an ash-flow unit is not welded because of the rapid cooling against the underlying land surface. And the top tends to be non-welded due to rapid loss of heat to the atmosphere. The central part of ash-flow units, however, may be so densely welded that they become a solid glassy obsidian.

The magma that cooled and crystallized below the surface formed bodies of granite, such as those now exposed at Redgranite and Montello. Smith (in press) shows that the rhyolites are nearly identical in chemical composition, indicating that they are part of the same magma. Van Schmus (1976) shows that both the granites and rhyolites originated about 1765 million years ago, perhaps during the waning stages of the Penokean Orogeny that affected most of northern Wisconsin. Van Schmus (1976) further shows that the rocks were subjected to a "thermal event" at 1650 m.y. ago that "reset" the Rb/Sr age of the rocks. Smith (in press) concludes that the sheets of ash flow rhyolite (and the Baraboo Quartzite) were folded during the 1650 m.y. event.

References

Asquith, G. B., 1964, Origin of Precambrian Wisconsin Rhyolites: Jour. Geology, Vol. 72, pp. 835-847.

Gram, V. E., 1947, Tectonic Features of the Utley Meta-rhyolite: Jour. Geology, Vol. 55, pp. 427-438.

Smith, E. I., (in press), Precambrian Rhyolites and Granites in South Central Wisconsin: Field Relations and Geochemistry: Geol. Society of America Bulletin.

Van Schmus, W. R., Thurman, E. M., and Peterman, Z. E., 1975, Geology and Rb/Sr Chronology of Middle Precambrian Rocks in Eastern and Central Wisconsin: Geol. Soc. America Bull. Vol. 86, pp. 1255-1265.

Weidman, S., 1904, The Baraboo Iron-bearing District of Wisconsin: Wis. Geol. Nat. Hist. Survey Bull. 13, 190 p.