The Discovery of Radioactive Minerals at Ruggles mine, Grafton, New Hampshire

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The discovery of radioactive minerals in New Hampshire (N. H.) can be traced back to 1844. At the July 17, 1844 meeting of the Boston Society of Natural History, Amos Binney, President of the Society at that time, read a note from James Englebert Teschemacher, a member of the Society, that described the discovery of uranium minerals at Beryl Mt., South Acworth, N. H. (then known as William's Ledge or Hill, Acworth, N. H.). They were described as "green and yellow cubic crystals and in the state of yellow oxide" (Binney 1844:191). Also in 1844, James Dwight Dana published the second edition of his "System of Mineralogy," but made no mention of uranium minerals in New Hampshire (Dana 1844). Ten years later in the 4th Edition, Dana (1854:430) mentioned autunite (under the heading "uranite," with autunite as a synonym) being found in "Ackworth, [*sic*] N. H." Acworth is again mentioned in Dana's 5th Edition, 5th sub-edition with George Jarvis Brush in Dana & Brush (1874:586-587). But by 1922, William Ebenezer Ford published an update to the textbook by Edward Salisbury Dana (J. D. Dana's son) in "Textbook of Mineralogy, 3rd Edition," where Ford also mentioned autunite under the uranite-group heading, but omitted New Hampshire altogether as an autunite occurrence (Ford & Dana 1922:616-617). By the 1930s, New Hampshire was apparently not a well-known locality for radioactive minerals, but that was about to change (De Ment & Dake 1947:13).

Ruggles mine in Grafton, Grafton County, N. H., is famous for supplying mica and feldspar for over a century (Davis 2019). The mine, its geology, mineralogy and, to a limited extent, its history are discussed and mapped in Sterrett (1923), Bannerman (1943), Page (1950) and Cameron et al. (1954). Page(1950:27) is particularly interesting in that it shows a map in Figure 5 where uranium minerals were found by 1944. Ruggles mine is now recognized for the variety of uranium primary and secondary minerals that have received worldwide attention and study. However, determining who made this discovery and when is not a simple matter.

This study will examine the information found in a variety of sources in the historical record, some fairly obscure. Obvious sources are published articles in scientific journals and magazines. Also of interest are articles published in popular hobbyist magazines. Less obvious sources include personal letters and scientific society symposia notes found in university archives of manuscripts and documents. These sources will be explored in the chronological order of described events (not necessarily the date of publication). A compilation of brief biographies is given to provide background information about the persons discussed. In the mid-1930s, the area of interest for radioactive minerals in New Hampshire shifted from Acworth to Grafton.

A mineral collector's attention may have been drawn to Ruggles mine around 1935 because the Whitehall Company had been contracted to mine feldspar for the Bon Ami company (Shaub 1938b). Mineral collectors rarely miss the chance to explore new mining operations.

The earliest account of collecting radioactive minerals from Ruggles mine occurred in the Autumn of 1935, described in an article written by Walter C. Shortle and published in the December 1936 issue of *The Mineralogist* (Shortle 1936). Shortle was a chemical engineer who lived in Laconia, Belknap County, N. H. with a passion for mineral collecting. This account described his visit to Ruggles mine in September and October of 1935, accompanied by his friend Myer J. Kassner, a jeweler and mineral collector also from Laconia. Their primary interest was in gem-beryl. Shortle (1939b) described the appearance of the mining operations at Ruggles in 1935 as "… when the pit was just started and quite small." Shortle reported finding uraninite and autunite (the only mineral he could readily identify using fluorescence), in addition to several other species tentatively identified as gummite, clarkeite, uranophane and uranospinite. In January of 1936, Kassner took some of these specimens to the American Museum of Natural History (AMNH) in New York City. He met with Dr. Herbert P. Whitlock (Curator of Minerals) and his assistant Dr. Frederick H. Pough, who reportedly confirmed uranocircite and, tentatively, uranospinite. There was no mention of the methods used to identify these minerals. De Ment & Dake (1947:13) also referred to the minerals Shortle reported and the doubtful identification of uranospinite. Kassner donated specimens to the AMNH collection. AMNH does have donations from Myer Kassner, but nothing he collected from Ruggles; no records with further details of this meeting could be found at AMNH (G. Harlow, pers. comm. 2021). Presently, clarkeite and uranospinite are listed as 'erroneously reported' for Ruggles mine, and uranocircite is not listed at all.

Wilbur J. Elwell (1936) described a "Mineralogical trip through New England" in the March 1936 issue of *Rocks & Minerals* magazine. He mentioned visiting "… the Ruggles feldspar quarries at Grafton, N. H. …" on October 29, 1935, but only commented on collecting beryl.

Shortle (1936) also mentioned attending the 18th Annual Symposium of the New Hampshire Academy of Science (NHAS) on May 29-30, 1936 in Goffstown, N. H. On the afternoon of May 30th, Dr. Richard E. Stoiber of the Geology Department at Dartmouth College and a geology graduate student, Edward P. Kaiser, gave a short 10-minute presentation titled "Some Radioactive Minerals from Grafton, N. H." (Kaiser & Stoiber 1936; De Ment & Dake 1947). The abstract states: "Radioactive minerals previously known from the Ruggles property are autunite, and a powdery alteration mineral hard to name. Unreported radioactive minerals are now found: uraninite, and gummite; both uranium oxides." The brief abstract does not indicate where or when autunite was previously reported [Note: Shortle (1936) was published 7

months after the NHAS symposium], nor when the specified minerals were collected or how they were identified. Aside from this verbal presentation, their paper does not appear to have been published, nor is it available from Rauner Special Collections Library, Dartmouth College, Hanover, N. H. (S. Noffke, pers. comm. 2021). It seems plausible that the Kaiser & Stoiber specimens were collected in late 1935 or early 1936.

Shortle (1936) mentioned three additional collecting trips to Ruggles with Myer J. Kassner, presumably over the summer of 1936. They reported finding torbernite (believed valid for Ruggles), carnotite and uranocircite (neither listed as valid species for Ruggles). He also mentioned a "very vivid green mineral" he suspected might be another alteration product, but never identified. Torbernite was also reported in Bjareby (1965).

In the Summer and Autumn of 1936, Dr. Benjamin M. Shaub of Smith College, Northampton, Massachusetts, collected specimens of uraninite from Ruggles mine which he had analyzed by Dr. Frederick Hecht at the Institute for Radium Research, Vienna, Austria for the purpose of radiometric dating. From the uranium-lead quantities, Shaub (in collaboration with Dr. Alfred C. Lane, Chairman, Committee on the Measurement of Geologic Time, National Research Council) calculated the age of Ruggles uraninite to be 302 mya (more recently measured as 329 mya by Foord et al. (1997)). Shaub published his results in *Science* magazine on 14 August 1937 (Shaub 1937:156).

Also in the Autumn of 1936, James F. Morton from the Paterson Museum in New Jersey visited Ruggles mine and collected numerous uranium minerals including: uraninite, gummite, autunite and uranophane, plus specimens of tourmaline and beryl. This was described in a letter Morton wrote to Dr. Benjamin Shaub (Morton 1937).

In April 1937, Walter C. Shortle traveled to Boston to visit with Dr. Esper S. Larsen at Harvard University. Dr. Larsen reportedly identified two specimens Shortle brought with him as uranocircite and uranospinite (neither mineral is currently recognized as a valid species for Ruggles mine). No details were given concerning the methods used for identification. This was described in a letter that Shortle wrote to Dr. Shaub (Shortle 1939b). No records with further details of this meeting could be found at Harvard (K. Czaja, pers. comm. 2021).

Dr. Shaub sent a letter to Dr. A. C. Lane on 14 January 1938 concerning, among other items, the fact that Shaub had sent a sample for analysis to Dr. Hecht in Vienna, Austria (Shaub 1938a). Shaub described the unidentified mineral as "… a bright yellow alteration product of the uraninite from Grafton Center." The results of this analysis or identification of the sample could not be found.

On 2 May 1938, Dr. Benjamin Shaub received a contract offer from Philip B. Verplanck, Vice President of Whitehall Company, Gilsum, N. H., to study the Ruggles pegmatite for their

feldspar mining operations (Verplanck 1938). Mr. Verplanck's name can also be found in other reports about mineral collectors wishing to obtain permission to collect at Ruggles mine.

Dr. Shaub published an article in *American Mineralogist* in May 1938 titled: "The occurrence, crystal habit and composition of the uraninite from the Ruggles mine, near Grafton Center, New Hampshire" (Shaub 1938b). This article is the first to provide a quantitative chemical analysis of the Ruggles uraninite. Shaub also included the radiometric dating he first reported in *Science* magazine (Shaub 1937), and showed a comparison table of radioactive mineral ages for New England specimens from Maine, Massachusetts, New York and Connecticut.

A letter written by Dr. Shaub on 26 August 1938 to Robert Vance at Ward's Natural Science Establishment in Rochester, N.Y., advised Vance that Shaub had shipped five cartons and two boxes of Ruggles uranium minerals (Shaub 1938c). The shipment contained 216 specimens of uraninite, gummite and uranophane, and 122 specimens of autunite. He also mentioned that "[i]n one box are six exceptionally fine specimens… ." Shaub explained how he obtained the specimens from the miners who pick up all the "… orange, yellow, and heavy minerals… ." The minerals he purchased from the miners were all that had been collected in the prior 12 to 18 months. Shaub also noted that during the summer of 1938, an occurrence of uraninite intimately associated with zircon (var. cyrtolite) was found during the mining of feldspar.

In March 1939, W. Shortle published an article in *The Mineralogist* about luminescent minerals (Shortle 1939a). From Ruggles, he mentioned autunite, uranocircite, uranospinite, and an unidentified mineral showing weak orange fluorescence [if radioactive, possibly dewindtite, phosphuranylite or soddyite]. As mentioned previously, uranocircite and uranospinite are erroneously listed for Ruggles mine.

A young Warder Cadbury provided *Rocks & Minerals* with a report about the Bay State Mineralogical Association in August 1939. He reported getting permission to visit from V. B. Verplanck at Whitehall Company for a trip to the "Glass Hill quarry." Reported minerals included montmorillonite, gummite, uraninite, tourmaline, quartz, muscovite and apatite (Cadbury 1939). Rudolf Bartsch also wrote a collector's column called "New England Notes" in *Rocks & Minerals* magazine from 1940 to 1944 (e.g., Bartsch 1940, 1941). This included several trips to Ruggles mine for radioactive and fluorescent species. Bartsch (1942) wrote that collecting at Ruggles would be suspended for the duration of the war [WWII].

Without a doubt, the most thrilling description of collecting at Ruggles between 1938 and 1942 was offered by Gunnar Bjareby in his memoir "50 Years of Collecting, Part 7" in *Rocks & Minerals* magazine (Bjareby 1965). He mentioned that a collector's access to Ruggles was

fairly easy then, even while the mine was being worked. Bjareby described finding a large zone of uranium mineralization about 30 feet up the mine wall. He then borrowed a ladder from a miner to climb up and hammer out spectacular specimens. Fine specimens were also lying about at the foot of the wall on the quarry floor.

In the 1950s, Dr. Clifford Frondel began a series of articles on uranium- and thorium-bearing minerals that included detailed analyses of physical and optical properties, composition and crystal structure (Frondel 1950a-c, 1952, 1956a-b). He also wrote an authoritative handbook on radioactive minerals, "The systematic mineralogy of uranium and thorium" published as Bulletin 1064 by the U.S. Geological Survey (Frondel 1958). In Frondel (1956b), he examined the composition of gummite, but left two species undefined and labeled them simply as "Mineral A" and "Mineral B." Frondel determined that Ruggles gummite consisted of a mix of kasolite, abundant soddyite, vandendriesscheite and abundant "Mineral A." Korzeb et al. (1997) and Foord et al. (1997) concluded that Mineral A consisted of a mix of schoepite-group minerals and uranyl oxide-hydroxide hydrates. Mineral A alters to form soddyite. A new mineral was added to the schoepite-group in 2011, paulscherrerite, which has been added to the list of species found at Ruggles (Brugger et al. 2011). Mineral B, also known as UM1956-02-SiO:CaHU, is described as the calcium analogue to kasolite. Figure 1. shows a classic Ruggles gummite specimen collected by the author that illustrates the concentration of uranium minerals along a zone boundary.

In summary, collectors found radioactive minerals at Ruggles mine beginning around 1935 and reported their finds in hobbyist magazines. An abstract for a 1936 NHAS symposium identified uraninite and gummite from Ruggles in a report from Dartmouth college geologists. The first technical analysis of Ruggles uraninite was published by Dr. Benjamin Shaub in 1938. Numerous New England mineral clubs posted field trips to Ruggles from the late 1930s to 1940s. The geology and mineralogy of Ruggles was discussed and mapped in Sterrett (1923), Bannerman (1943), Page (1950), and Cameron et al. (1954). Frondel's excellent handbook of uranium and thorium minerals in 1958 included many specimens from Ruggles mine. With Ruggles mine property under new ownership, the future looks promising for exploration of previously inaccessible areas.

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Short Biographies

Bartsch, Rudolf Carl Bjorn	Reports for "New England Notes" in *Rocks & Minerals* (early 1940s); member Boston Mineral Club; supplied C. Frondel with New England radioactive specimens for study in 1950s [see "Acknowledgements" in Frondel (1956b)]; [b.1883 Nov 22; d. 1966 Aug]
Binney, Amos	M.D. (1826, Harvard); co-founder Boston Society of Natural History; [b. 1803 Oct 18; d. 1847 Feb 18, Italy]
Bjäreby, Alfred Gunnar	Mineralogist, artist (painting & sculpture; studied in Sweden, Paris, Boston); [b. 1899 Feb 11, Sweden; d. 1967 June 5]
Brush, George Jarvis	Ph.D. (1852, Yale); mineralogist; [b. 1831 Dec 15; d. 1912 Feb 5]
Cadbury, Warder	Bay State Mineralogical Association reports for "Club and Society Notes" in *Rocks & Minerals* (1949); [b. 1925 Jan 3; d. 2004 Aug 18]
Dake, Henry Carl	D.MD. (1919, North Pacific College); publisher of "*The Mineralogist*"; [b. 1896 Jan 7; d. 1969 Oct 21]
Dana, Edward Salisbury	Ph.D. (1876, Yale); son of James D. Dana; editor, *American Journal of Science*; [b. 1849 Nov 16; d. 1935 Jun 16]
Dana, James Dwight	B.A. (1833, Yale); received honorary Ph.D. from U. Munich, LL.D. from Amherst College, Harvard, Edinburgh; Wollaston Medal, Copley Medal, Grand Walker Prize etc. ; geologist, mineralogist, biologist; editor, *American Journal of Science*; [b. 1813 Feb 12; d. 1895 Apr 14]
De Ment, Jack Andrew	Honorary Doctor of Science (1955, Western States College); chemist, metallurgist; author on fluorescence; [b. 1920 Feb 6; d. 1992 Dec 27]
Elwell, Wilbur James	Mineral collector, author in *Rocks & Minerals* (1936-1953); [b. 1884 Sep 24; d. 1978 Oct]
Foord, Eugene Edward	Ph.D. (1976, Stanford); scientist, U.S.G.S.; [b. 1946 Nov 20; d. 1998 Jan 8]
Ford, William Ebenezer	Ph.D. (1903, Yale); mineralogist, Professor of Mineralogy, Yale Sheffield Scientific School; [b. 1878 Feb 18; d. 1939 Mar 23]

Frondel, Clifford	Ph.D. (1939, MIT); Harvard mineralogist, among the first to view specimens returned from the moon; discovered 48 new species; authoritative author on radioactive minerals; etc.; [b. 1907 Jan 8; d. 2002 Nov 12]
Hecht, Frederick (Friedrich)	Ph.D. (1928, U. of Vienna); Institute for Radium Research, Vienna, Austria; [b. 1903 Aug 3, Austria; d. 1980 Mar 8, Austria]
Kaiser, Edward Peck	Ph.D. (1941, MIT); Geology instructor at Dartmouth; [b. 1912 Apr 24; d. 2001 Nov 20]
Kassner, Myer James	C.G. (1936, AGS); Jeweler, Gemologist in Laconia NH; [b. 1896 Aug 30; d. 1976 May 1]
Lane, Alfred Church	Ph.D. (1888, Harvard); Chairman, Committee on the Measurement of Geologic Time, National Research Council; [b. 1863 Jan 29; d. 1948 Apr 15]
Larsen, Esper Signius, Jr.	Ph.D. (1908, UC-Berkeley); Harvard Prof. Petrography 1923-1949; [b. 1879 Mar 14; d. 1961 Mar 8]
Morton, James Ferdinand	M.A. (1892, Harvard); Curator of minerals, Paterson NJ Museum; [b. 1870 Oct 18; d. 1941 Oct 7]
Pough, Frederick Harvey	Ph.D. (1935, Harvard); assistant to H. P. Whitlock at AMNH; [b. 1906 Jun 26; d. 2006 Apr 7]
Shaub, Benjamin Martin	Ph.D. (1939, Cornell); Prof. Geology / Mineralogy at Smith College, Northampton, MA ; [b. 1893 Jan 12; d. 1993 Mar 23]
Shortle, Walter Charles	B. Ch. E. (1931, Smith); member of New Hampshire Academy of Science; Residence: 21 Sanborn St, Laconia, NH; [b. 1910 Jun 15; d. 1970 Jul]
Sterrett, Douglas Bovard	B.S. (1903, Yale); geologist, mineralogist with U.S. Geological Survey; [b. 1882 Apr 3; d. 1969 Feb 9]
Stoiber, Richard Edwin	Ph.D. (1937, MIT); Geology instructor at Dartmouth in 1935; identified as “R. S. Stoker” in Shortle (1936) and “Stoiber” in Shortle (1939b); [b. 1911 Jan 28; d. 2001 Feb 9]
Teschemacher, James Englebert	Scientist; fellow of American Academy of Arts & Sciences; [b. 1790 Jun 11, England; d. 1853 Nov 9]

Verplanck, Philip Bronck	Vice President, Whitehall Company, Gilsum, NH; [b. 1898 May 11; d. 1974 Jan 6]
Whitlock, Herbert Percy	B.Ch.E. (1889, Columbia); Curator of Gems & Minerals 1918-1941, American Museum of Natural History, NYC; [b. 1868 Jul 31; d. 1948 Feb 22]

Figure 1. Example of Ruggles mine uraninite and “gummite” (altered uraninite). The specimen also includes numerous uranium secondary minerals, some fluorescent like autunite and uranophane. Overall dimensions: 9.5 x 5 x 4.5 inch (24.1 x 12.7 x 11.4 cm); 9.4 pounds (4.28 kg). Field collected by, photographed by and in the collection of the author.