Volcanic Ash in South-Central North Dakota

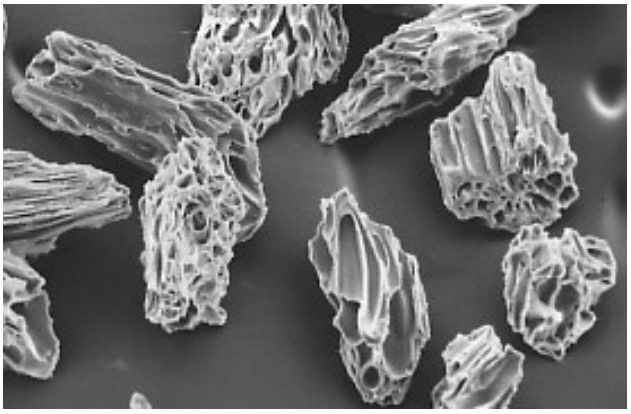
By Edward C. Murphy

Early Work

Mankind has been aware of the beneficial uses of volcanic ash for thousands of years. The Romans discovered Pozzolana (powdery volcanic ash named for its occurrence near Pozzuolli, Italy) and mixed it with lime and water to form concrete piers at a colony called Cosa, located north of Rome. Portions of these piers, almost 2000 years old, still exist today.

Volcanic ash deposits are present in northern Sioux, southern Morton, and central Emmons counties in south-central North Dakota. These deposits are about 68 million years old. T.W. Stanton was the first to identify volcanic ash in the Linton area in 1917. This deposit has been referred to as the Linton ash. Stanton noted the ash was 26 feet thick and occurred in the lower part of the Fox Hills Formation. In 1952, S.P. Fisher greatly expanded the known areal extent of the ash finding it in several localities in both central and south-central Emmons County. Ten years later, Oscar Manz (1962) authored a report for the North Dakota Geological Survey on the pozzolanic properties of ash samples within a 35-square-mile radius of Linton. Manz estimated there were 500 million tons of volcanic ash in the Linton area. Artzner (1974) and Forsman (1992) reported on the petrography of the Linton ash. In an article written in 1992, J. Mark Erickson (St. Lawrence University) suggested the Linton ash was deposited in a distributary channel and portions of an estuarine embayment of the Western Interior Seaway.

The Linton ash exposed along Spring Creek north of Linton. Approximately 20 feet of volcanic ash (pumicite) is exposed in this stream cut. Two characteristics of volcanic ash are its bright color (typically dazzling white to light gray) and its light weight.



Scanning electron photomicrograph of glass grains from a volcanic ash deposit. These glass grains were molten when they were ejected into the atmosphere from a volcano. The cooling glass trapped gas bubbles thus creating a high percentage of void spaces in the glass grains, which is why volcanic ash or pumicite is so light in weight.

The Volk Family

In the late 1950s, Lenus Volk, a Linton native and minerals landman, asked his uncle what the white layer was along the side of a hill in his corn field. His uncle, who reportedly grew some of the best corn in Emmons County, informed him that it was volcanic ash and it was a great natural fertilizer. Intrigued, Lenus leased the mineral rights to a portion of the deposit, formed a company named Beaver Valley Volcanic Ash, and began a 35-year-long effort to promote beneficial uses of the Linton ash. Despite this untiring promotion and several successful tests involving Linton ash, the only commercial project that Beaver Valley Volcanic Ash was able to bring to fruition was the use of ash in a three-quarter-mile-long road base beneath a paved road on the northside of Linton. Lenus is quick to point out that 35 years later that stretch of road is still in great shape, outlasting the surrounding stretches where ash was not used. Although laboratory testing on the Linton ash and lime had indicated this material would be a stable base, the North Dakota Department of Transportation and the Federal Highway Administration required field testing of the mixture, which is why it was used in the section of road at Linton.

Table 1. Various Tests of Linton Ash

1962 – North Dakota Geological Survey investigates the pozzolanic properties of the Linton ash.

1970 – Linton ash used along with lime to stabilize road base beneath a paved road on the northside of Linton.

1973 – Linton ash was used to successfully remove phosphate from samples obtained from Minnesota lakes and municipal sewage.

1975 – Concrete test cylinders were made with various amounts of volcanic ash and subjected to three edge bearing tests.

1975 – Volcanic ash was applied on ice at Crown Butte. When the ice melted, the ash settled to the bottom and, according to the North Dakota Game and Fish Department, appeared to result in a decrease in blue-green algae due to the resulting decrease in phosphates.

1978 – The University of North Dakota performed shaking type batch tests and continuous flow type column tests to determine the potential of the Linton ash to remove phosphorous from waste water. Based on these tests, volcanic ash was recommended as a means of phosphorous removal from waste water.

1987 – North Dakota Concrete Products Company performed a series of tests on drain tile that were made by substituting 15, 20, and 25% of the cement with Linton ash. The results were generally favorable.

1995 – Approximately 400 tons of Linton ash was used as a road base for a half mile stretch of ND Highway 6 about 10 miles south of Mandan. The road base for one 1/4 mile stretch consisted of ash and another 1/4 mile consisted of ash and lime.

2003 – North Dakota Geological Survey maped all volcanic ash deposits within the Linton 100k sheet at a scale of 1:24,000. Six samples of ash were chemically analyzed.

In 1988, Lenus's daughter, Greta Weisser, went on an extended leave from her job with a utility company to follow her father's dream of developing the Linton ash deposit. Greta established a company called VolAsh of North Dakota with a goal to mine approximately 100,000 tons of ash per year. She based this amount on a 10% substitution of ash in Portland cement at the volumes that were being consumed in a three-state area (North Dakota, Minnesota, and South Dakota). A number of companies tested Linton ash to determine if it would fulfill their needs, including the Weyerhauser Corporation, General Electric, Corning Glass, and the Minnesota Mining and Manufacturing Company (3M). In 1993, 3M obtained a patent on an oil containment boom that contained volcanic ash. Linton ash had been used in the development of the prototype. Still, even with Greta's persistent dedication to marketing the deposit, VolAsh of North Dakota was unable to fulfill the Volk family dream of major utilization of the Linton ash. In 1992, Greta returned to full-time employment with a consulting firm in the utility industry, abandoning her full-time endeavor to develop the ash deposits.

In 2002, Greta Weisser formed NURTURE, Inc. along with her daughter, Kate Kruse, Kate's lifelong friend, Sara Huey, and Sara's mother, Marcia Huey (a lifelong friend of Greta's). NURTURE, Inc. is a Minneapolis-based company that produces and distributes a growing line of volcanic ash deposits - all natural products for the home, garden, and body. Their current line includes odor removers (NURTURE AIR™), gardening minerals (NURTURE PLANTS™), and skin care products. The company sells its products in specialty shops and from their website (www.nurture.net).

Lenus Volk (right) recently stopped by the North Dakota Geological Survey to discuss his numerous attempts to develop the Linton ash.

NURTURE, Inc. products (left to right) nurture air and nurture plants. Labels read 100% natural volcanic minerals.

Out-of-State Inquiries Drive Recent Survey Work

During the fall of 2003, the Geological Survey and the North Dakota Department of Economic Development and Finance each received inquiries concerning the state's volcanic ash deposits from different out-of-state companies. Given this interest, we decided to undertake a detailed assessment of the deposits. Approximately 70 outcrops of ash within a one million acre area (the Linton 1:100,000 scale sheet) were investigated and plotted on ten 1:24,000-scale quadrangle maps. More than two dozen ash samples were collected in the Linton area, six of which were submitted for chemical analysis. The ash contains about 60% silica and 13% aluminum oxide. A PIXE analysis of the Linton ash tested for 75 elements but only detected 21, including titanium (0.16 %), copper (7.4 ppm), gallium (13.4 ppm), rubidium (136 ppm), strontium (183 ppm), and barium (628 ppm). The Linton ash deposit extends over an area of at least 70 square miles and contains approximately one billion tons of ash, 380 million tons of which are under less than 50 feet of overburden.

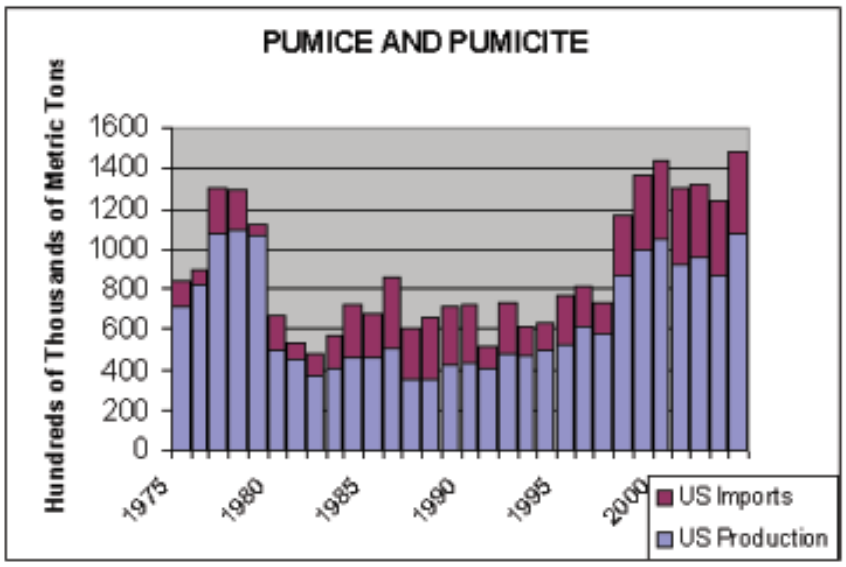
The Breien ash is exposed along both sides of the Cannonball River east of the town of Breien. The stream cut in the distance contains about 20 feet of ash (photo taken looking west). This is one of five volcanic ash deposits that occur within the Linton 100k sheet. These ash deposits occur within rocks that become progressively lower stratigraphically from west to east, but may represent volcanic ash from the same ashfall.

US and World Market for Pumice and Pumicite

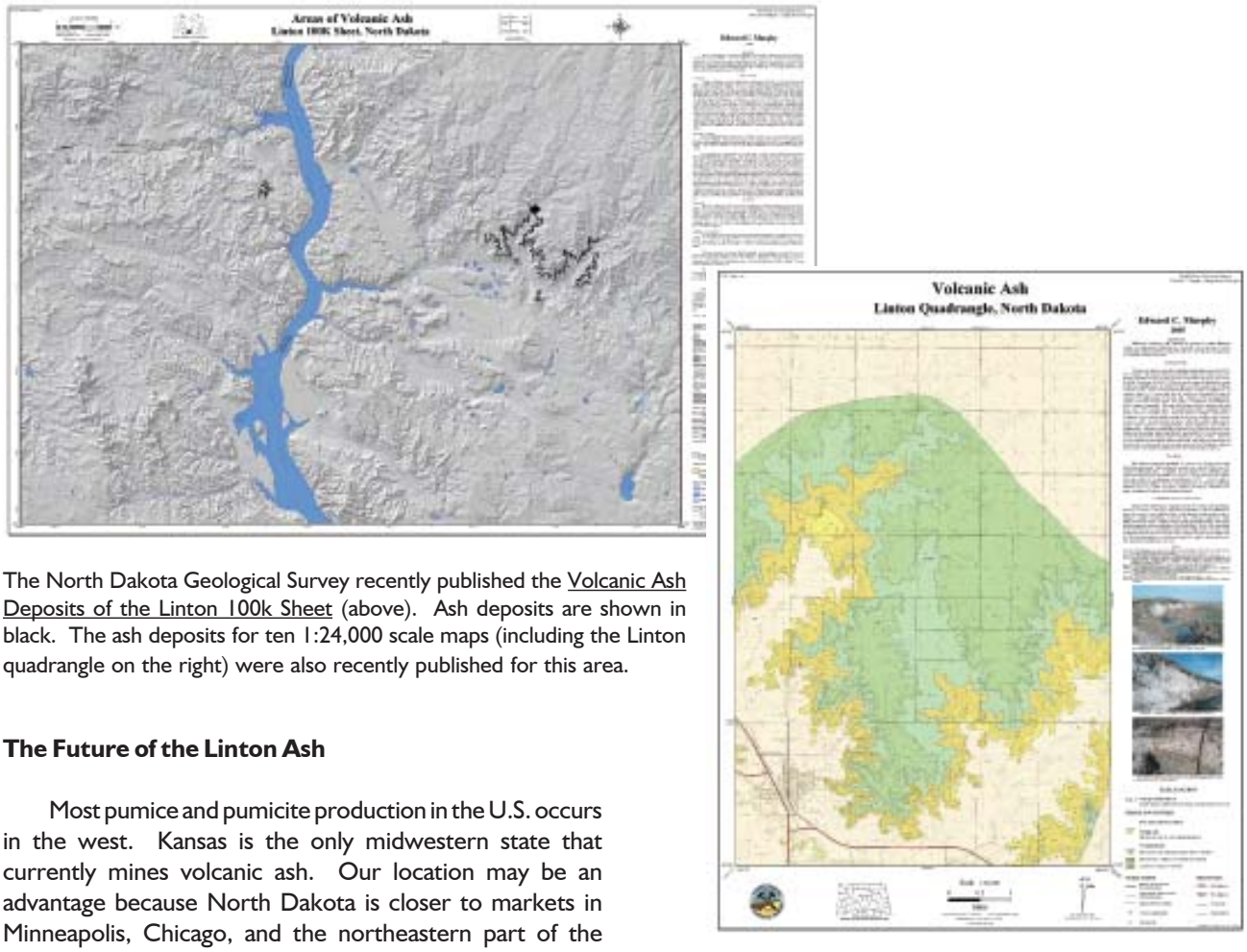
According to U.S. Geological Survey and U.S. Bureau of Mines reports, pumice and pumicite (volcanic ash) mining peaked in the United States in 1978 at 1.1 million metric tons. In 2004, U.S. production was 1.07 million metric tons, only slightly lower than this record amount. U.S. imports of pumice and pumicite exceeded 400,000 metric tons in 2004 and has averaged more than 300,000 metric tons for the last ten years. Most of these imports came from Greece and Italy.

Pumice and pumicite production in the U.S. comes from 18 mines in eight states (Arizona, Oregon, New Mexico, California, Idaho, Nevada, Kansas, and North Dakota). NURTURE, Inc. mined less than 100 metric tons of the Linton ash in 2004 and less than 100 tons in the previous two years. All told, only a few thousand tons of Linton ash have been mined in the last 35 years.

In recent years, approximately three-fourths of the pumicite mined in the U.S. has gone towards building blocks and the remaining one-fourth towards abrasives, concrete, horticulture, landscaping, stone-washed jeans, and other applications. Zeolites, hydrous aluminum silicate minerals, form naturally in volcanic ash due to interaction with groundwater. These minerals have an open structure which enables them to accommodate a number of positive ions. As a result, zeolites act as molecular filters and ion exchange agents and, as advertised by NURTURE, Inc., are well suited for soil enhancement, odor control, etc.



U.S. production and imports of pumice and pumicite from 1975 to 2004. For the last ten years, the average price for pumice and pumicite has been $24.21 per metric ton.



The North Dakota Geological Survey recently published the Volcanic Ash Deposits of the Linton 100k Sheet (above). Ash deposits are shown in black. The ash deposits for ten 1:24,000 scale maps (including the Linton quadrangle on the right) were also recently published for this area.

The Future of the Linton Ash

Most pumice and pumicite production in the U.S. occurs in the west. Kansas is the only midwestern state that currently mines volcanic ash. Our location may be an advantage because North Dakota is closer to markets in Minneapolis, Chicago, and the northeastern part of the United States. One thing is certain, if the Linton ash ever undergoes large scale utilization, it will likely be the result of the tireless work of three generations of Volks; Lenus, Greta, and Kate.

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