Part One: An Overview of sand and gravel resources in Northwest Indiana

Chapter 1:

Sand and Gravel Deposits in Northwest Indiana

Sand is a common material and is found all over the earth. However there is more of it in northwest Indiana than in most other places.

Definitions

Sand is formed by the weathering or the natural disintegration of rocks,[1] particularly of granite or sandstone. Unlike other natural resources such as coal or iron ore, sand and gravel are defined by their particle size rather than mineral composition. By definition, sand grains range in size from one-sixteenth of a millimeter to two millimeters. The next smaller size grains are called silt. Larger unconsolidated particles are called gravel[2]—although gravel particles can also be classified by size (small to large) as granule, pebble, cobble, and boulder.

Millimeters	Wentworth Grade	
>256	Gravel	Boulder
>64		Cobble
>4		Pebble
>2		Granule
>1	Very coarse sand	
>1/2	Coarse sand	
>1/4	Medium sand	
>1/8	Fine sand	
>1/16	Very fine sand	
>1/256	Silt	
<1/256	Clay	

Sand is most commonly made of quartz, the world's most common mineral. Sands come in a wide variety of colors; its grains may be purely quartz, mostly quartz, partially quartz, or entirely non-quartz. Indiana Dunes sand is mostly quartz.

by Arthur E. Anderson. 1913
[James Fisher Collection: CRA]

Sand is found in great abundance in northwest Indiana. This abundance is the direct result of glaciation and the natural geological processes of wind and water movement that have occurred since the last glaciers left northwest Indiana approximately 14,000 years ago.

It was glaciers that scooped out bedrock and created Lake Michigan. It was also glaciers that broke up that bedrock, grinding much of it, and, as they left, depositing it on both the ground and in the lakes. Thus, many of the major sand and gravel deposits in the state were originally placed in deposits formed either directly by glaciers (such as one of the many moraines in the state) or by glacial meltwaters.

However, in the thousands of years since the glaciers left, rivers and particularly the currents within Lake Michigan have moved great quantities of sand and gravel and deposited them elsewhere. Much of that sand and gravel has been deposited at or near the southern end of the lake.

[1] Carr and Webb, 1970, p. 1.
[2] Patton, 1976, p. 53.

This is because for most of the history of the lake, sand has been moving southward, carried by lake currents on both sides of the lake.[3] It was estimated by geologist Charles W. Shannon in 1911 that over the millennia at least half a *billion* cubic yards of sand had been naturally deposited on Lake Michigan's beaches by the waters of Lake Michigan.[4]

Waves at the south shore of Lake Michigan wash sand up onto the beach. Then when it dries much of it is blown away from the lake by dry northwest winds. When the wind slows up, it drops the sand that it's carrying. Various natural objects such as grass, trees, or rocks can cause the wind to slow up. Such items can then cause the wind to drop enough sand that small piles of sand are formed—which themselves can cause more wind to slow up causing even more sand to be dropped. In this way, large sand dunes can be slowly formed. The process is similar to the way that wind blows dry snow into drifts.

Except at times when the wind is exceedingly strong, gravel is simply too heavy to be moved by winds. It is not too heavy, however, to be carried by the moving waters of fast-moving streams or the waves of Lake Michigan. When these waters slow up, just like the winds, they drop their sediment loads. Gravel then can accumulate in riverbeds wherever water tends to slow up. This also happens most days along the beaches of the Great Lakes where waves have the strength to wash gravel up onto the shore, but not enough strength to carry it back into the lake.

Geologic History

Moraines: Duneland's Glacial Deposits

During the last years of the Pleistocene Ice Age there were numerous advances and retreats of the Lake Michigan lobe of the glacier, with most retreats followed by an advance not quite as extensive as the previous one. The last of these advances that invaded the Calumet Area occurred during the Crown Point Phase,[5] a 2400-year long period that began about 15,200 years ago. The Valparaiso, Tinley, and Lake Border moraines were built during this time period.

The Valparaiso Moraine was formed first. It is shaped like a huge, 200-mile long letter 'U' away from but still roughly parallel to the shoreline of Lake Michigan. The melting glacier released huge amounts of sediment (called till) along its stationary southern edge forming a long curved series of ridges and hills known today as the Valparaiso Moraine. It is the largest and highest of the moraines in the Calumet Area and together with the smaller Tinley/Lake Border Moraine forms the dominant landscape in much of the outlying Calumet Area. (See Map 1.) It gets its name from Valparaiso where the moraine is narrower, higher, and steeper than in places farther west.

The Tinley Moraine, just north of the Valparaiso Moraine, was formed after a glacial retreat and readvance. A short retreat followed by another period of equilibrium resulted in the **Lake Border Moraine**, the smallest of these moraines to be formed. The Lake Border Moraine includes a long band of till that extends from the Bailly Homestead area east and north into Michigan.

[3] Pettijohn, 1931, p. 433.
[4] Shannon, 1912.
[5] The Crown Point Phase is named for the deposits made at that time at what is now Crown Point, Indiana.

Characterized by a haphazard "swell and swale" (hill and lowland) landscape, the moraines today comprise just a small percentage of the land area of LaPorte County but more than 50% of Lake and Porter Counties.

Although many other moraines were created by glaciers in what are now Indiana and Illinois, the Valparaiso and Tinley Moraines are significant because they form the Eastern Continental Divide, which separates the rivers that flow north and east to the North Atlantic from those that that flow west and south to the Gulf of Mexico.

Lake Michigan's Many Shorelines: The Creation of Waves and Wind

The three major ancient shorelines of Lake Michigan, the Glenwood, Calumet, and Tolleston, once had characteristics similar to the present shoreline. However, even though natural and manmade processes have greatly altered them, portions of these former shorelines can still be recognized by the careful observer.[6]

The Glenwood Shoreline

Glacial Lake Michigan (formerly called Lake Chicago) was formed about 14,500 years ago when the Lake Michigan lobe melted back from the Tinley/Lake Border Moraine. Much of its melt waters were then trapped between the ice to the north and the U-shaped moraine on the west, south, and east.

The Glenwood Shoreline is the oldest and highest (at 640 feet above sea level) and the furthest from the lake of the three major former Lake Michigan shorelines. Dunes of the Glenwood Shoreline are not very conspicuous. Today the shoreline forms a long band of low, forested hills generally between U.S. Highways 12 and 20 extending from Wagner Road northeast toward and beyond Greenwood Cemetery in Michigan City. Further west much of the original shoreline has been buried by more recent dunes or is south of the Duneland area.

The Calumet Shoreline

The Calumet Shoreline, a bit north of and 20 feet lower than the Glenwood, was formed about 11,800 years ago when the lake level stabilized at about 620 feet above sea level. Today this ancient beach can most easily be seen along U.S. Highway 12, through eastern Porter County. In Michigan City, the Indiana State Prison and the International Friendship Gardens are on the Calumet Shoreline.

The Tolleston Shorelines

The Tolleston Shoreline got its start 4,700 years ago. It is north of, and about another 15 feet lower than, the Calumet Shoreline. As it formed, it was separated from the older Calumet Shoreline by a narrow band of lake water called the Calumet Lagoon. Roughly 3,800 years ago the lake level starting dropping and the lagoon was separated from Lake Michigan forming a long series of wetlands. Cowles Bog, Dunes Creek, and the Great Marsh are all remnants of this one-time part of Lake Michigan.

The Tolleston Shoreline extends from these wetlands north to the current lakeshore. It contains the tallest dunes in the area. In western Porter County and in Lake County, what is sometimes called the High Tolleston Shoreline is a sand ridge quite separate from the modern dunes to the north.

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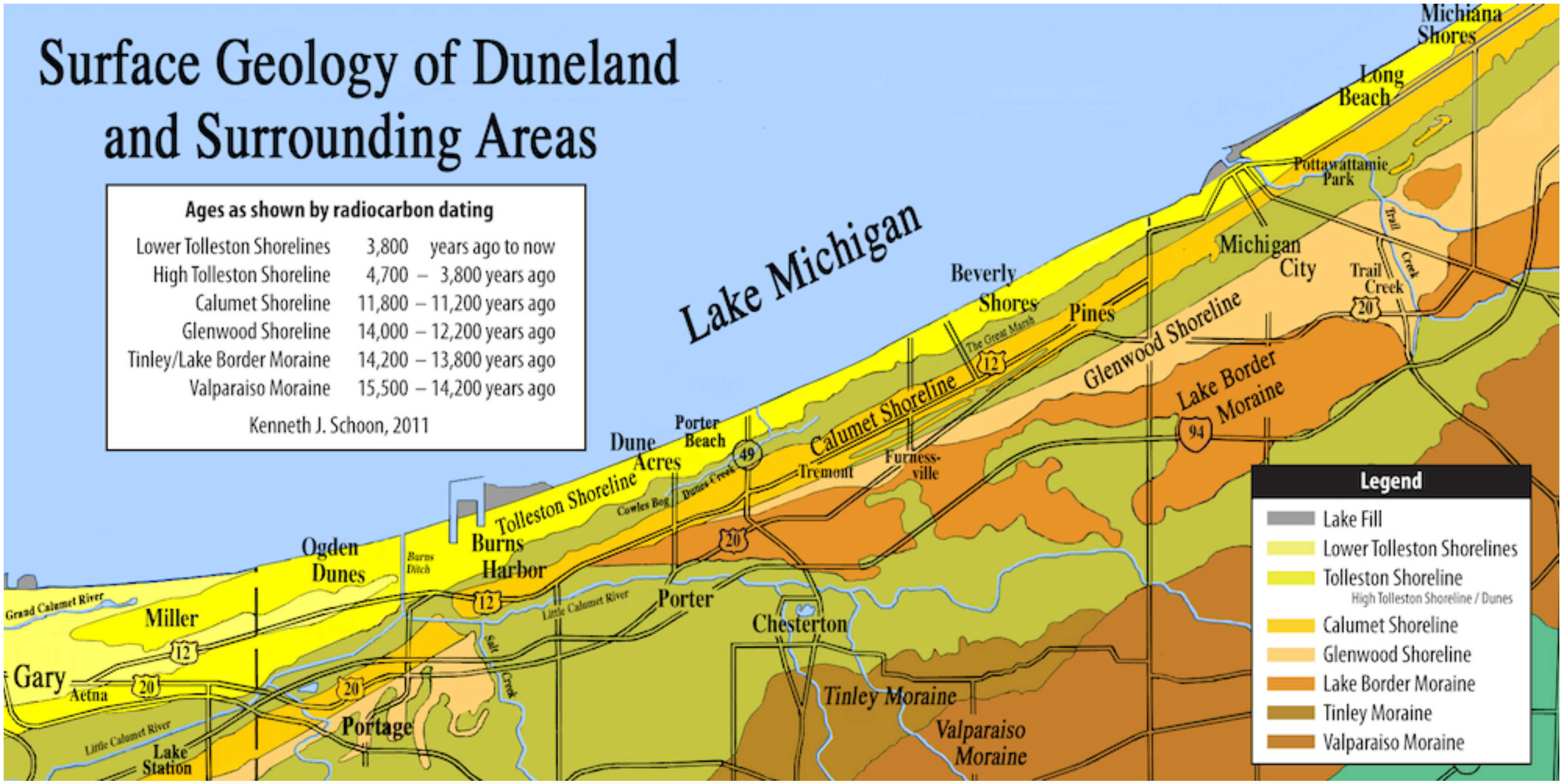
[6] See Schoon, 2003, for detailed descriptions of the location and formation of the ancient shorelines of Lake Michigan.



Map 1. Surface Geology of Duneland and Surrounding Areas. *Dreams of Duneland*, 2013

As the lake receded from its highest level of the Tolleston phase it did so in a pulsating manner. Thw water level would drop because of drought or erosion south of Lake Huron; the water level would rise during periods of greater rainfall. Toward the west, this rising and falling resulted in more that 150 small beach ridges between Miller and Chicago, all roughly parallel to the lake-shore. Geologist J Harlan Bretz called these ridges the lower Tolleston beaches. Originally they ranged in height from 5 to 12 feet and averaged about 150 feet in width. Although most of them were leveled as the industrial cities from Chicago to Gary were developed, a few at Gibson Woods in Hammond, western Gary, and the Miller Woods section of the National Lakeshore can still be seen.

Physical and Chemical characteristics of Duneland Sand

Mineralogy

About 90% of the sand grains in both Duneland beach and sand dunes are quartz. Usually present are various feldspars. As would be expected of any sands that earlier had been transported by glaciers there is a large number of additional minerals that can be found in small amounts. This includes the minerals augite, diopside, hornblende, garnet, epidote, zircon, tourmaline, and iron ores. On the beach the weight of all these heavy minerals combined ranges from 0.5 to just 1.1%.

Whereas glaciers transport materials of many varying sizes and weights, the wind is highly selective in its action. Dune sand, made entirely of sands that had been blown away from the beach, is not surprisingly, slightly finer in texture and lower in total heavy mineral content than beach sand.[7] Interestingly, the mineral hornblende, which has an intermediate density but a somewhat flat grain shape, tends to be found with quartz and feldspars rather than with the heavier minerals. One fact that has tended to make mining of sand dunes easier is the fact that most dunes are nearly homogenous in content.[8]

Chemical Composition of Dune Sands[9]

Location of Dunes	**Percentage of:**							
	SiO_2	**Al_sO_3**	**Fe_2O_3**	**MgO**	**CaO**	**Na_sO**	**TiO_2**	**ZnO_2**
Lake Michigan beach[1]	91.9	3.8	0.53	0.41	1.4	0.38	0.085	0.0073
Tolleston beach[2]	91.4	4.7	0.50	0.26	0.8	0.38	0.071	0.0032
Calumet beach[3]	86.7	5.0	1.4	0.79	3.0	0.32	0.28	0.0068
Glenwood beach[4]	89.7	6.2	0.82	0.21	0.6	0.55	020	0.0079

Notes:
1. Lake Michigan sand collected from the Producers Core Sand Co. pit in LaPorte County
2. Tolleston Beach sand collected from the Bos Sand Company pit in Porter County
3. Calumet Beach sand collected from the Crisman Sand Company pit in Porter County
4. Glenwood Beach sand collected from Lake County

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[7] Pettijohn, 1931, p. ,453.
[8] Bieber and Smith, 1952, p. 13.
[9] Carr, 1971, p. 15.

Grain Size Composition[10]

Location of Dunes	Sieve size percentage[11]					
	28	**48**	**80**	**100**	**200**	**<200**
Lake Michigan beach[1]	0.45	21.57	69.78	7.34	0.40	0.65
Tolleston beach[2]	0.68	90.38	7.54	1.08	0.29	0.02
Calumet beach[3]	2.51	87.02	7.48	1.15	1.15	0.69
Glenwood beach[4]	0.21	53.56	34.98	4.94	5.79	0.52

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Each dune has an average grain size that may differ from that of nearby dunes.[12] In general, dunes have finer sands in the western part of the Duneland area, and gradually become coarser eastward. Few sand grains are spherical; most are "sub-round." The dark heavy minerals are sub-round to round.[13] Both the beach sand and dune sands are porous and permeable. Most rainwater that falls on these sands soaks into the ground. Runoff is rare.

Buried sands in Duneland, those more than just a few inches below the surface, are nearly always damp. Thus sands lifted by a crane from a dune or sand ridge and placed into railroad cars are damp. Analysis done by Bieber and Smith (1952) showed that as much as 5 percent of the weight of wet sand was water.[14]

Color

Duneland sand generally ranges in color from near white to light buff. The older the sand (i.e. from the older, ancient shorelines) the darker its color. The dark color comes from oxidized iron in some of the dark mineral grains.[15]

Buried objects

Bones and antlers of animals have been found at or near the bottoms of some dunes. Occasionally bones of prehistoric animals have been discovered. Though not common, an Indian artifact was found near the base of a dune in a Crisman Sand Company pit in Calumet Shoreline dune sand.[16] Far more common, at least in the younger dunes, are old tree trunks still in upright positions. No wood has been found in Tolleston or older dunes.[17]

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[10] Ibid.
[11] Tyler series sieve sizes
[12] Bieber and Smith, 1952, p. 20.
[13] Bieber and Smith, 1952, p. 21.
[14] Bieber and Smith, 1952, p. 22.
[15] Bieber and Smith, 1952, p. 23.
[16] Ibid.
[17] Ibid.

Gravel

Gravel deposits are not nearly as common in northwest Indiana as are sand deposits. The major deposits in Indiana were formed directly by glaciers or by glacial outwash as the various lobes of the glacier were either at equilibrium or were receding. According to geologists Donald Carr and William Webb only minor amounts can be obtained from the beach and from modern stream deposits.[18]

The size of gravel grains varies from location to location. Among the factors that influence particle size are the size of the original particles supplied by the bedrock from which they came, the hardness (and thus resistance to abrasion) of the particles themselves, and the distance that they were transported by both glacial ice and water. The mineral composition of a gravel deposit can be very complex with up to 20 different minerals present.[19]

Gravel deposits associated with glacial moraines have been rather small and have been found mainly by chance. Most have been found when folks were excavating for building foundations, wells, fence posts, or drainage ditches.[20]

[18] Carr and Webb, 1970, p. 15.
[19] Carr and Webb, 1970, p. 9.
[20] Bieber, 1949, p. 221.