**Lessons from Michigan's Oldest Concrete Pavement – Still Serving After 100 Years**

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**ABSTRACT**

In 1906, the village of Red Jacket, Michigan (the present day village of Calumet) constructed over 1½ miles of street with a two layer cast in place stamped concrete system known as a granitoid brick block concrete pavement. Today, some of this pavement is still exposed, carrying traffic after 100 years of service. Historical records about the construction and the results of a laboratory analysis of a core specimen from the pavement are presented. The durability of this concrete is remarkable since it was constructed without air entrainment in a severe freeze-thaw climate. The granitoid pavement of Calumet has long outlived the major paving material competitor of its day: creosoted wood block pavement.

## INTRODUCTION

At the dawn of the 20th century the village of Red Jacket, Michigan was thriving economically due to the booming copper mining industry. With the Industrial Revolution underway, the demand for copper was high. In 1906, the Calumet and Hecla Mining Company, a large local mining company, made a profit of nine million dollars (1). That same year, a major public works project was undertaken to pave most of downtown Red Jacket. Both creosoted wood block pavement and granitoid brick block concrete pavement were used for the project. Presently, approximately four city blocks of the original pavement are still in service as constructed: the granitoid pavement in the vicinity of the intersection of Portland and 7th Streets. Figure 1 shows a photograph taken in 1956 of a sign erected on the southwest corner of Portland and 7th Streets to celebrate 50 years of service of Michigan's oldest concrete pavement (2). This followed an earlier dispute within the state over the rightful designation of the state's oldest concrete pavement (3,4,5,6). The next year in 1957, a carefully-worded historic marker was erected in Detroit to recognize the "World's First Mile of Concrete Highway" a stretch of pavement constructed in 1909 on Woodward Avenue between Six and Seven Mile Roads, pavement that was replaced in 1922 when the street was widened (7,8). To this day, ambiguity remains in the State Historic Preservation Office's description of the Red Jacket pavement, which is listed on the State Register of Historic Sites, but is described simply as "among the oldest extant concrete pavement in Michigan" (9). In 2006, the Village Council of Calumet granted permission to retrieve a core speciment from Portland Street to commemorate 100 years of service. This paper presents findings from the analysis of the core specimen, and findings from a review of historical documents related to the construction.


**FIGURE 1:** 1956 unveiling of historical marker. Pictured from left to right – E. C. Hoffman, past president of the village of Calumet, N. F. Kaiser, the village clerk of Red Jacket in 1906, C. F. Winkler, engineer of the Houghton County Road Commission, and G. D. Kennedy, past president of the Portland Cement Association. Reproduced from the cover of the 1956 August 30th issue of Michigan Roads and Construction (1).

## HISTORY

### Bidding

On January 26th, 1906, the Village Council of Red Jacket advertised for bids for the paving of streets, the construction of concrete walks and combined curb and gutters to commence during the summer of 1906. On February 15th the council held a special session to consider the submitted bids for street improvement (10,11). Several paving materials were available to choose from, and the selection of the correct material was important to the Village Council members who took multiple trips to see examples of the various paving materials. Exactly which materials would be chosen by the village leaders was a source of much public interest, as the local newspaper, the Copper Country Evening News (CCEN) reported that "nothing but paving talk can be heard" (10). Materials available at the time included: brick, macadam, creosoted wood block, and concrete, (referred to as granitoid at the time). The fact that the public took interest in what material the streets were to be paved with was best demonstrated when a group of prominent businessmen petitioned the city that brick not be used to pave 6th Street (10,11,12).


**FIGURE 2:** USGS aerial photography from 1998 showing extent of the 1906 street improvement project, (left) and white arrows to show present day extent of exposed granitoid pavement (right).

In considering the merits of the potential materials, none received more press than granitoid. Granitoid was favored by the Village Council from the very beginning due to its low cost and durability (13,14). In addition to being well received by the Village Council, it was suspected that the more conservative businessmen would also like it because it had been shown to be a very durable material given that sections laid in Chicago eight years prior were still in good shape (13).

On February 27th, contracts were awarded to two companies to pave the majority of the town (15,16). These two companies were the R. S. Blome Company from Chicago and J. J. Byers, from Houghton. Blome was awarded the contract for most of the paving with granitoid, while the remaining work was awarded to Byers who agreed to use creosoted wood block. The contracts were signed on March 1st (17,18) and surety bonds approved for

the contractors on April 3rd (19). In total, $125,000 worth of street paving and improvement bonds were approved for sale by the village of Red Jacket on April 9th (20). Figure 2 is an aerial photograph of downtown Red Jacket with overlays to show which streets were scheduled to be paved with what material. Figure 2 also illustrates the current extent of pavement that remains in it original condition.

**Construction**

*Excavation, Subgrade, Curb and Gutter*

Construction was started by Byers on April 23rd, and by Blome on May 1st, 1906 (21,22). The citizens of Red Jacket reacted positively to the street improvement project. The local news reported favorably about the large number of summer jobs that would be created by the roadwork. On April 23rd, when reporting that contractor Byers had begun work, the CCEN stated that "It is likely the improvements will take up most of the summer and that a large number of men will be employed. The employment of many men will be welcomed in Calumet where so many at present are out of work" (21). Similarly, prior to commencement of work by Blome the CCEN reported that the work "will require many laborers," and that "a force of laborers will be wanted" (23).

Construction began with the lowering of existing water and sewer mains to ensure that no damage would be done to the pipes during construction (21,24). Once the mains were lowered, trench excavation for conduits commenced, as the Village Council had passed a resolution that "all overhead wires in the village be placed underground this summer" (25). Aesthetics were very important to citizens of Red Jacket; when rumors spread that trees along 8th Street would be cut down to make way for construction, citizens "interceded with village authorities and engineer, and obtained a promise that the trees should remain" (26). According to the village specifications, all excavation was to be done by hand, except when rock was encountered (27). At least one instance of blasting was reported when a tree root was blown through a window (28). For conduit, 3" diameter paper pipes were used and concrete poured around the pipes. Approximately 45 manholes were placed along the conduit lines. The depth of the manholes varied from 6 to 10 feet. They were 4 feet in diameter, and built with two rings of brick to yield 8" thick walls. The tops tapered down to 2 feet in diameter, and had covers weighing at least 350 pounds (27). After the conduits and manholes were placed, the trenches were backfilled and graded. In sections requiring fill either sand, gravel, or stone were used, and compacted in 6" lifts. For cut sections, the only requirement was that organic matter be removed and that the subgrade be compacted. Concrete curb and gutter was placed on 6" of clean gravel or cinders. Six inch thick concrete foundations were installed for streets with railways (27).

*Paving*

Paving with granitoid began with the placement of a 5" layer of damp sand, gravel, or crushed stone atop the subgrade. After compaction, a 5¼" layer of concrete was placed. The village specifications describe the mix as containing 1 part portland cement, 3 parts sand, and four parts crushed stone (27). The specifications further state that mixing was to be performed (by hand) on a mixing board. Sand and cement were mixed dry, and water added sufficient to make a stiff mortar, after which the crushed stone was added. Mixing continued, with the occasional addition of water, until all the stone was coated with mortar, after which the concrete was transferred by shovel and rammed into place. Before setting, the concrete was topped with a 1¾" thick mortar layer consisting of 1 part portland cement, and 1½ parts granite screenings or sharp clean sand "thoroughly mixed and wetted to the proper consistency and carefully worked to surface brick shapes" (27). The timing of the placement of the mortar over the concrete as described in the specifications contrasts with a newspaper statement that "concrete is allowed at least two days to set before the granitoid is placed on it" (29). However, there may have been some confusion, as the same article describes a situation where the granitoid workers, (the workers placing the final mortar layer) "suspended operations for a few hours in order to allow the concrete men to catch up and keep the required distance" (29). Figure 3 shows drawings from a Blome 1910 patent of a pavement block stamping device that traversed on rails and stamped the brick pattern into the fresh mortar (30). Although no mention was made of mixing machinery in the specifications, the use of mixing machinery was mentioned in several newspaper accounts (31,32,33,34,35).

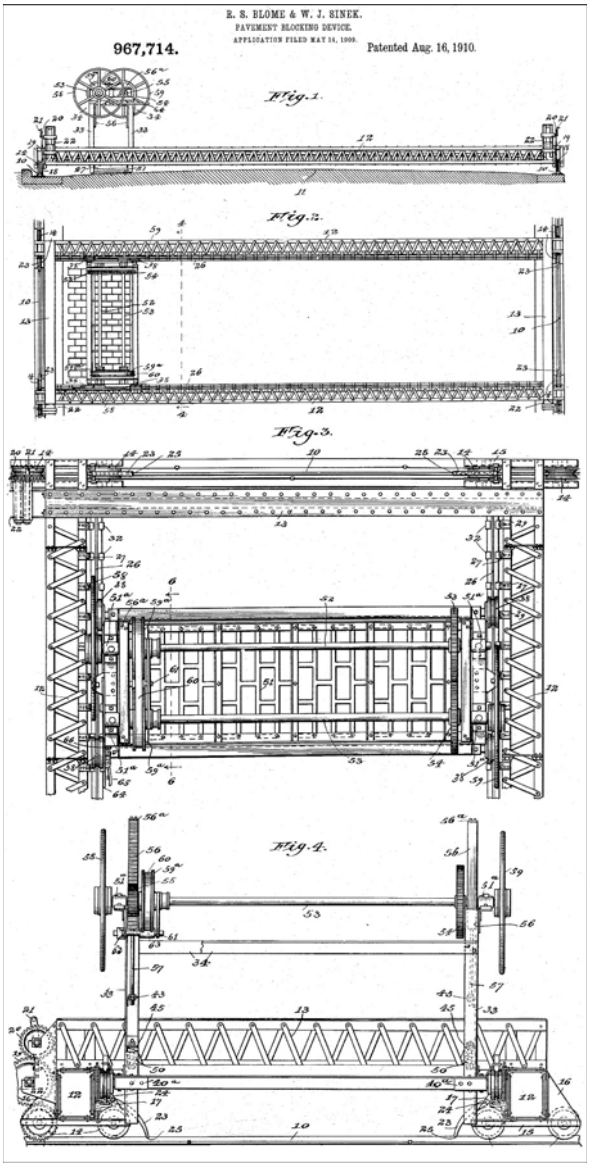


**FIGURE 3:** Drawings from patent for pavement block stamping device (30).

Paving with creosoted wood block began with a concrete foundation made in a manner similar to the concrete base of granitoid pavement, but with 7 parts crushed stone instead of 4. After moist curing for a minimum of 7 days, a 1" layer of sand was placed over the concrete, followed by the wood blocks, and leveled with a 5 ton roller. After leveling, expansion joints along each side of the street were filled with bituminous cement or pitch. Sand was then swept onto the surface of the blocks to a thickness of ¼" (27). Figure 4 shows a photograph of a wood block left over from the project. As the wood block paving operation was beginning in Red Jacket, problems were reported with a wood block paving project completed the previous summer on College Avenue in the nearby town of Houghton (36,37,38). The secretary of the Kettle River Quarries Company (KRQC), manufacturer of the wood blocks, suggested that "the sand was swept off too soon, and in consequence the blocks were not given substantial time to settle" (37). Wood block pavements were understood to require adequate time for the sand "to work in between the blocks" as the "creosote which oozes out of the blocks in warm weather mixes with the sand and forms cement which welds the blocks firmly together" (38). Problems with wood block paving did not stop at College Avenue; the appearance of streets that had already been paved with wood block in Red Jacket was also causing alarm (39). The CCEN reported that a KRQC engineer responded to an urgent call from the Village Council and arrived on July 19th (40). In addition to the company engineer and the village engineer, a civil engineer from Minneapolis was called to investigate (40). Rumors were circulating that Byers might sub-let its contract for 6th St. to Blome (41). The three engineers met to discuss the problem and to decide whether 6th Street would be paved with wood block or not (42). On July 12th the Village Council voted unanimously to release Byers from its contract to pave 6th St. and give that work to Blome so that the important street would be paved in the more reliable granitoid (42,43).

Construction with wood block on 8th and Oak Streets was completed on August 9th, after some experimentation on the affected areas with the addition of different sands and creosoted oil, although problems continued to persist (31,32,44). Construction with granitoid was completed on September 29th (45). The CCEN had only good things to say about the R. S. Blome Company, writing that the company "has done remarkably well," and that "nothing but favorable comment is being heard on the way the R. S. Blome Company has carried out its contract" (45,46) There was even talk of a public vote of thanks towards the Village Council for its handling of the project (47). During the time that Blome was hard at work paving sections of downtown Red Jacket, they received additional contracts from around the country. On August 8th, the CCEN reported that Blome had been awarded a contract for $200,000 to pave the town of Gary Indiana with granitoid (48). Likewise, over the next two months, Blome won additional contracts from the United States Government to pave parts of Washington, D. C. for $100,000, and several more to pave streets in Michigan City, Indiana and Chicago (49,50). The CCEN reported that "granitoid as a paving material is rapidly coming to the front in the country," and that "Red Jacket is to be congratulated for securing it for some of its streets" (49). Many of these projects were advertised in a brochure published by the R. S. Blome Company circa 1910, including images from the 1906 paving project, as shown in Figures 5 and 6 (51).

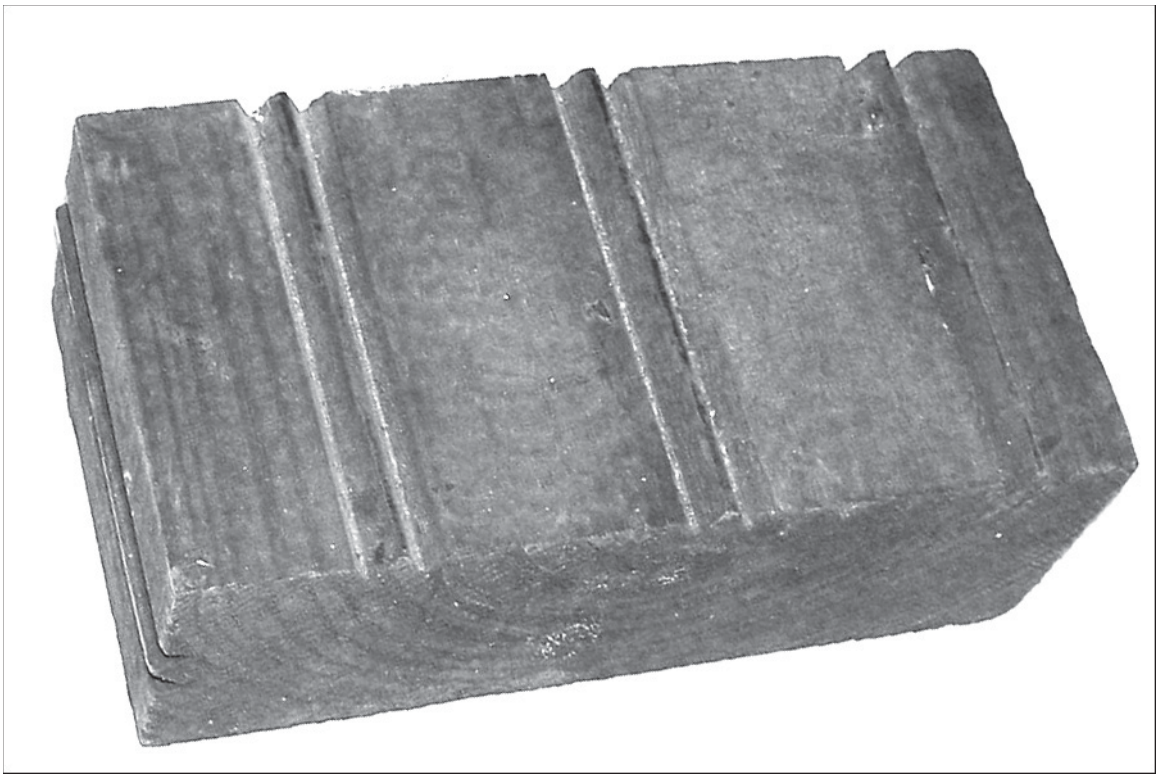

**FIGURE 4:** Creosoted wood paving block from 1906, from personal collection of J. M. Johnson, past coordinator of the Village of Calumet Historic District Commission, approximately 7” x 3” x 4” in dimension.

**FIGURE 5:** Southerly view of 6th Street, showing newly finished granitoid pavement, reproduced from circa 1910 advertisement brochure (51).

**FIGURE 6:** Northerly view of 6th Street, showing newly finished granitoid pavement, reproduced from circa 1910 advertisement brochure (51).

## CORE SPECIMEN EXAMINATION

The core specimen was retrieved from the granitoid pavement of Portland Street in March of 2006. The core was photographed and cut into slabs. Figure 7 shows photographs of the core and Figure 8 shows scanned images of a polished slab, both before and after treatment to enhance the appearance of voids and cracks. The two layers, mortar on top and concrete below, can be clearly seen in Figures 7 and 8. The stone and sand in both the mortar and concrete were from local trap rock mine tailings. The tailings originated from Late Precambrian Keeweenawan basalts, although the basalts likely came from the Calumet and Hecla Lode, a sedimentary conglomerate rock composed of eroded basalt fragments, and rich in native copper (52). The hardened cement paste of the mortar was very dense and without any sign of air entrainment. The hardened cement paste of the concrete was less dense, with abundant entrapped air. The appearance of the concrete reflects the construction practice of ramming, a method commonly employed at the time (53). The following sequence, reproduced from a construction handbook published in 1908, describes seven basic steps for producing concrete (53):

1. Loading barrows to transport the cement, sand and stone to the mixing board.
2. Transporting and dumping the material.
3. Mixing the material by turning with shovels and hoes.
4. Loading the concrete by shovels into barrows.
5. Transporting the concrete to place.
6. Dumping and spreading.
7. Ramming.

Newspaper accounts indicated that a mixing machine was used instead of the hand-mixing described in the third step, but the subsequent steps outline a likely sequence for the placement of the concrete base. The same handbook provides further insight into the ramming process, stating “Concrete that is mixed with very little water requires long and hard ramming to flush the water to the surface… Tests show that dry mixtures when carefully deposited and well tamped produce the strongest concrete… Concrete made “sloppy” requires no ramming at all, and very little spading” (53). A modern interpretation of the concrete base might be that the concrete was poorly consolidated, but the appearance seems consistent with pavement construction practice of the day. The entrapped air voids did not appear to significantly affect the strength of the concrete, as compressive strengths of 5,480 psi were reported in laboratory tests performed by the Portland Cement Association during an investigation of the pavement in 1956 (2).

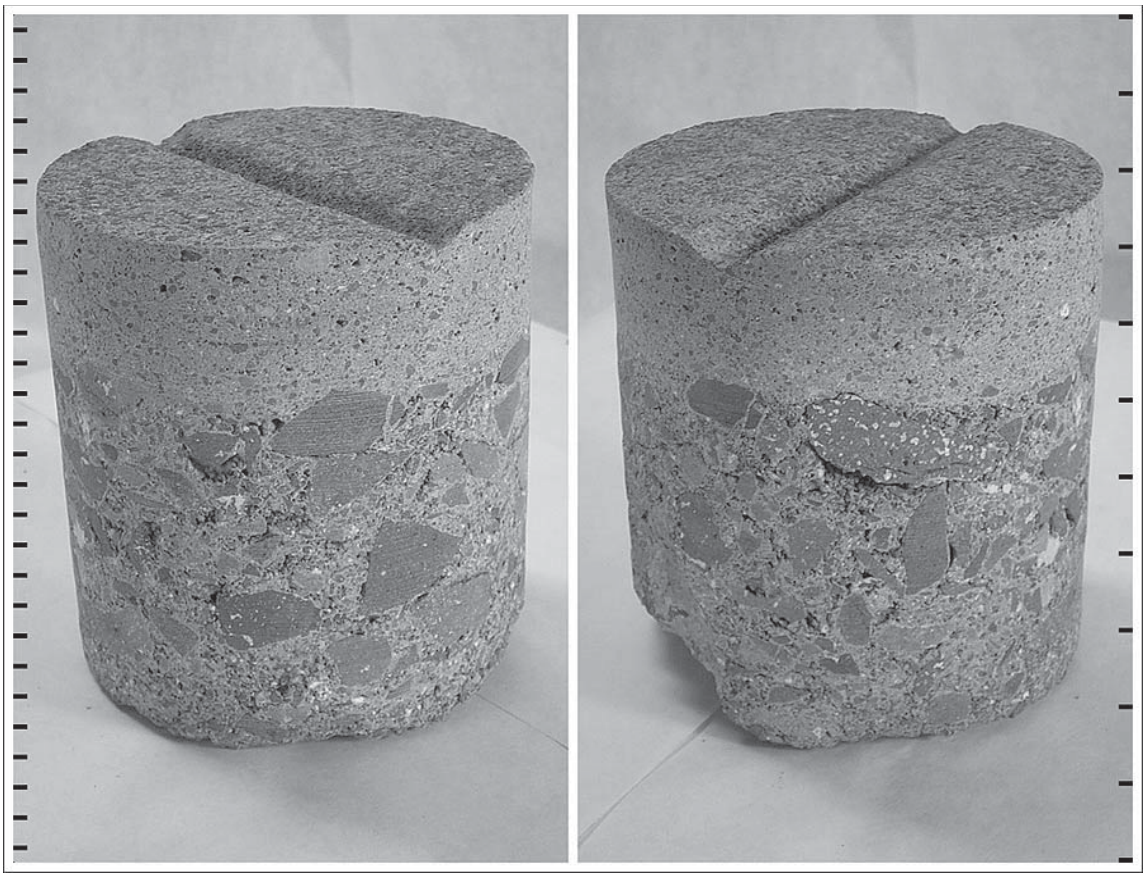

**FIGURE 7:** Photographs of core specimen as retrieved from Portland Street, tic marks along left side approximately every cm, along right side every inch.

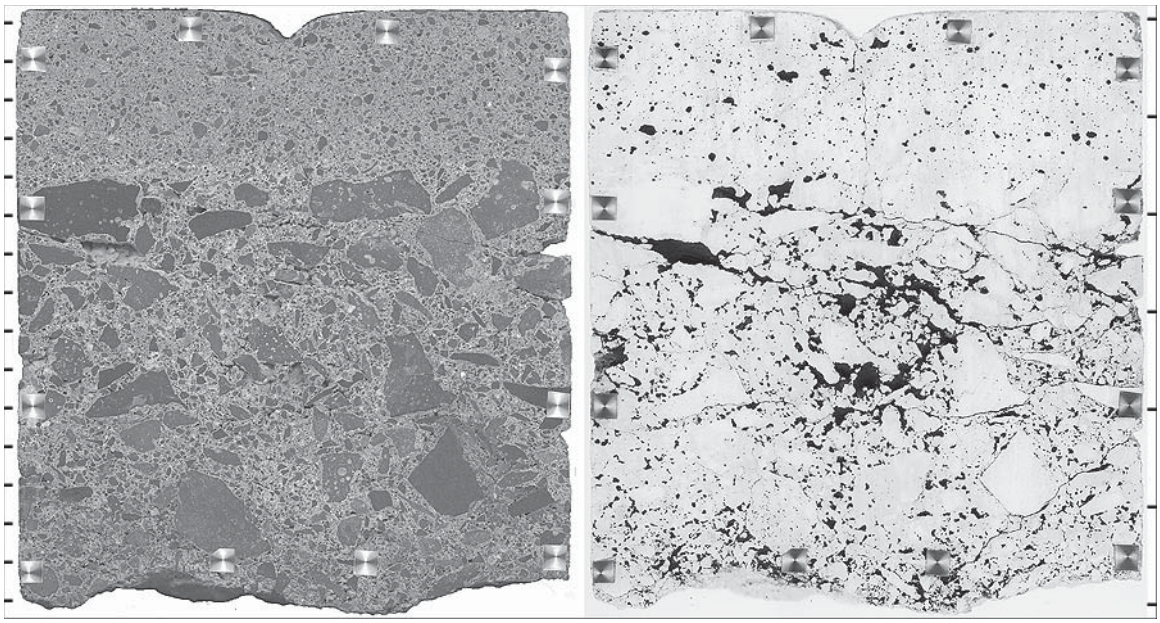

**FIGURE 8:** Scanned image of slab cut from core as polished (left) and after treatment to enhance visibility of air voids and cracks (right). Bright stickers observed around perimeter of slab were placed to assist with image alignment. Tic marks along left side every cm, along right side every inch.

Thin sections were prepared from the core specimen and observed using a petrographic and environmental scanning electron microscope (ESEM). Petrographic microscope images comparing the concrete and mortar portions are shown in Figure 9. The contrast in density between the cement paste of the mortar and the cement paste of the concrete is best observed in the epifluorescent images at the bottom of Figure 9. The abundant entrapped air and relatively porous cement paste of the concrete base has resulted in extensive carbonation. Carbonation is best observed in the crossed-polars image, which shows bright highly birefringent patches of calcium carbonate in the cement paste. The cement used contained abundant coarse cement grains on the order of a tenth of a millimeter in cross-section, some of which are indicated with white arrows in the plane polarized light images at the top of Figure 9. The center portions of these large grains were often unhydrated, and contained pristine cement phases such as tabular alite crystals, [3(CaO)($SiO_2$)] (typically abundant in modern portland cement) rounded belite crystals, [2(CaO)($SiO_2$)] and periclase crystals, [MgO] as shown in the back-scattered electron (BSE) and characteristic elemental x-ray maps collected using a Philips XL-40 ESEM as shown in Figure 10. A newspaper account suggested that Alpha brand portland cement may have been used (22). At the time, Alpha cement was produced at two locations near the town of Alpha, New Jersey, and one location near Martins Creek, Pennsylvania (54).

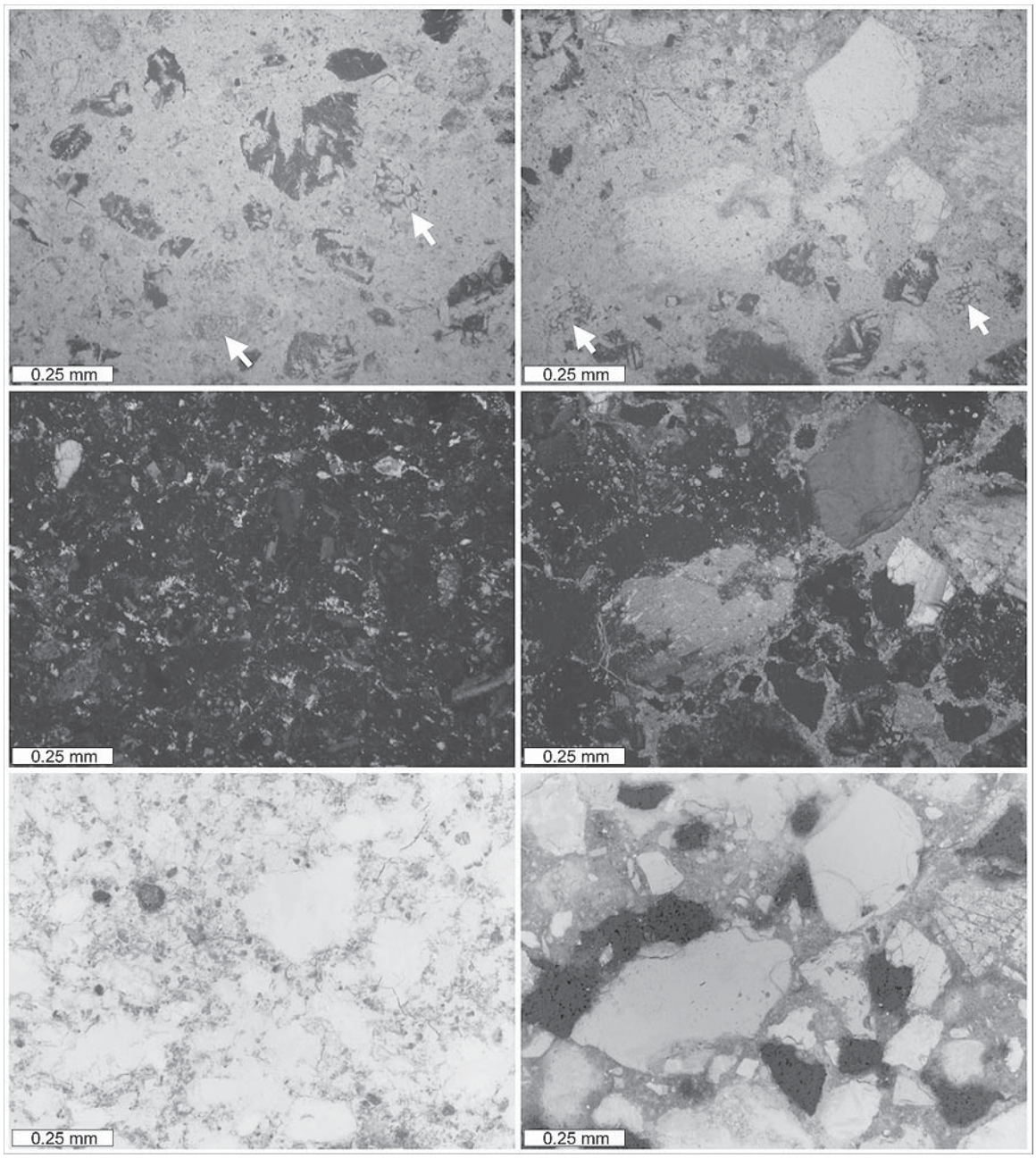


**FIGURE 9:** Petrographic microscope images from mortar (left hand side) and concrete (right hand side). From top to bottom: plane polarized light, crossed polars, and epifluorescent mode (darker regions indicate increased porosity in these inverted epifluorescent mode images). White arrows indicate large cement grains.

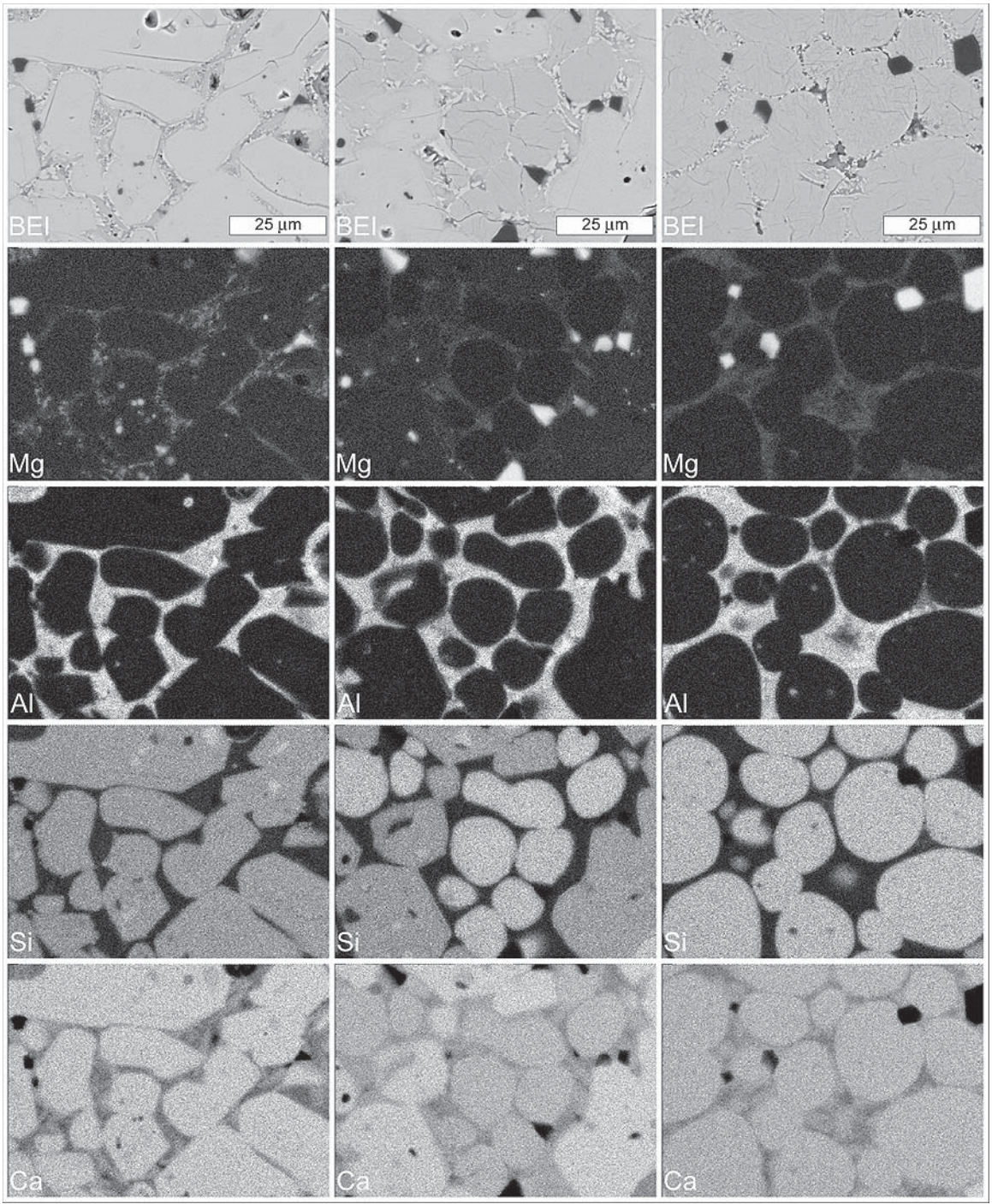


**FIGURE 10:** BSE images and corresponding characteristic elemental x-ray maps from unhydrated interior portions of three different large cement grains.

## DISCUSSION AND CONCLUSIONS

Although the topic of this paper may be of interest to some, a fair question to ask is what relevance it has to today's construction materials and techniques. In other words, how can the information obtained from this 100 year old pavement be used to improve modern concrete pavement?

First of all, the durability of the granitoid pavement is somewhat surprising given the absence of entrained air, especially the complete absence of any scaling in the existing pavement (Figure 12). This is likely due to the high density of the cement paste in the upper mortar layer which suggests significantly reduced capillary porosity as compared to the cement paste of typical modern concrete used for paving. In fact, the microstucture shares a lot of similarity to that of modern ultra-high performance concrete (UHPC) that is also produced without air entrainment. It is believed that the extremely low capillary porosity of UHPC cement paste effectively eliminates the need for air entrainment to ensure good freeze-thaw durability. Figure 11 compares BSE images of the cement paste from the granitoid pavement upper mortar layer to the cement paste of a modern UHPC. As can be seen, the two mortars share some distinct similarity in microstructure even though they are separated by 100 years of technology. In contrast, modern paving concrete has much greater capillary porosity. It is plausible therefore to assume that the low capillary porosity of the hydrated cement paste in the 100 year old mortar provided a level of protection to the underlying, poorer quality concrete, although cracking is evident in the underlying concrete as seen in Figure 8. It can only be speculated as to what led to this very dense microstructure, but it is likely that a relatively low water-to-cement ratio was used, the mixture was thoroughly densified, and wet curing was employed. Further, the cement used at that time was coarsely ground and contained a high percentage of dicalcium silicate (belite) as compared to modern cements that are more tricalcium silicate (alite) rich. This led to slower hydration producing more calcium silicate hydrate compared to calcium hydroxide. Similar effects can be obtained with modern cements if they are blended with a suitable pozzolan, such as Class F fly ash, silica fume, or metakaolin, or a slag cement.

The use of a higher quality surface over a poorer quality base concrete is a technique employed in some European countries that has been investigated in the U.S., including the I-75 European Pavement Demonstration Project constructed near Detroit, MI in 1993. As high quality materials, in particular aggregate, become increasingly scarce, the use of a two-layer pavement system becomes more attractive, especially considering material such as recycled concrete could be effectively used in the lower layer. It is also worth noting that the aggregate used in the concrete was mine spoil, making use of an available resource that required minimal transport distance and minor additional processing. Thus, this 100 year old pavement demonstrates the feasibility of using locally available waste materials in an extremely effective manner, a lesson that we would be wise to learn from given today's emphasis on sustainability.

And finally, if creosoted wood block pavement is the distant cousin of modern asphalt concrete, then certainly modern portland cement concrete is the great-grandchild of granitoid pavement. The same discussions engaged in by the Village Council of Red Jacket regarding pavement type selection mirror those held today, in which issues of economics and longevity are played out. With ever tightening budgets and increasing costs, long-lasting pavements with built in versatility will be the most sustainable choice. The use of an innovative two-layer system not only created an incredible durable surface, it also allowed for the purposeful shaping of that surface to optimize it for the type of traffic it was design to serve…horses (the stamped in brick pattern was designed to provide traction for horses). Similarly, in a modern concrete pavement, a high quality optimized surface layer might be designed to be easily shaped to enhance traction while minimizing noise. It might also include such innovative features as high light reflectance to cool the urban environment and enhance visibility, catalytic coatings to treat air pollution, high porosity to move runoff to pervious shoulders, or possibly even enhanced to generate energy. Much as creosoted wood has fallen into disuse, there may come a time in the not-too-distant future where the intrinsic versatility and durability of concrete, as well as its low amount of embodied energy, will make it the unrivaled choice for all pavement surfaces.

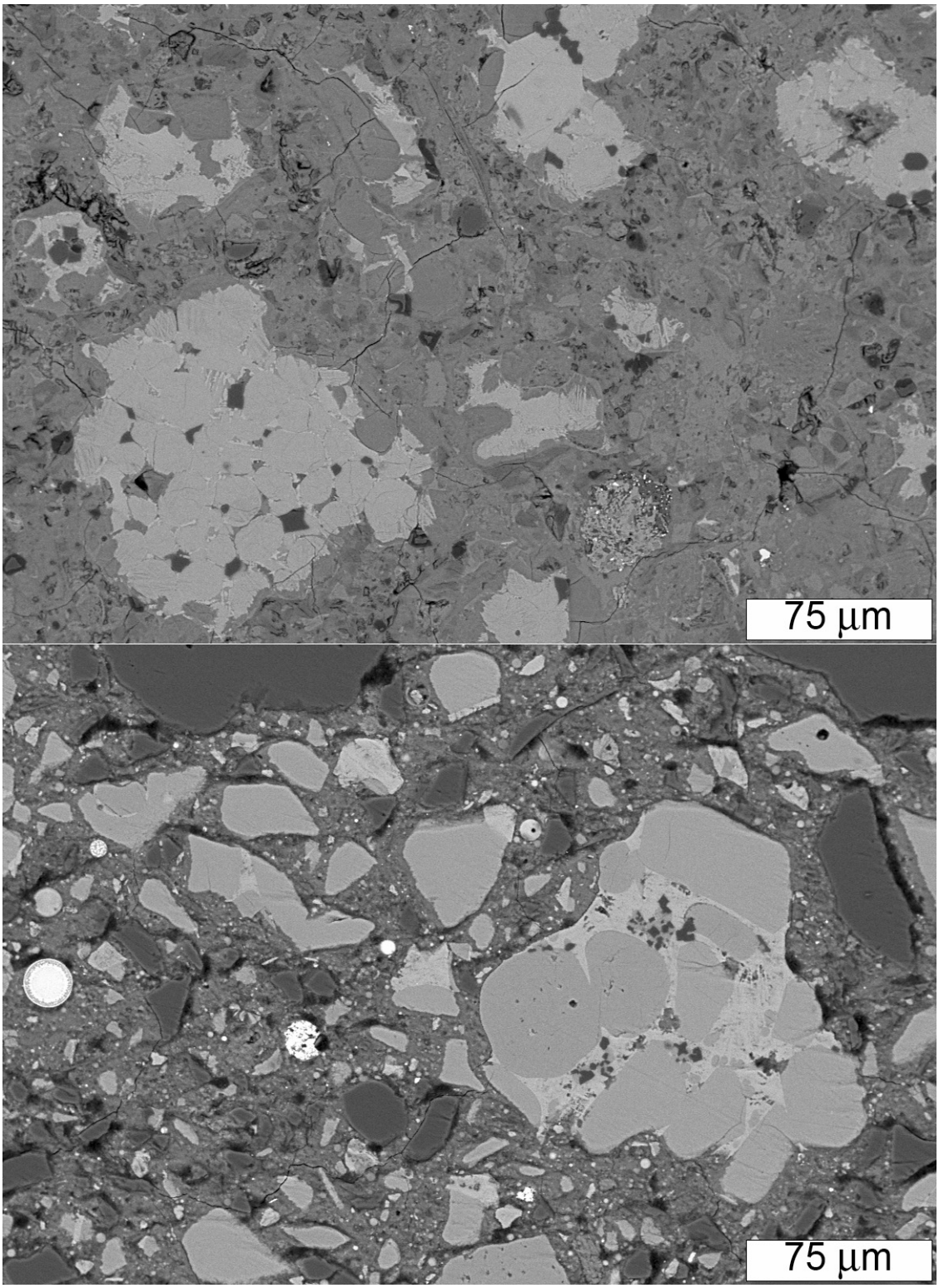


**FIGURE 11:** BSE images comparing the capillary porosity of cement paste from the granitoid pavement upper mortar layer, (top) to the capillary porosity of cement paste from modern UHPC (bottom).

**FIGURE 12:** Recent picture of Portland Street in Calumet, MI showing no scaling after 100 years of service.

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32. Work Started – Blome Firm Concreting 6th Street Preparatory to Paving, Large Force of Men on Job, Operations Will be Pushed so Attention Can Be Turned to Other Streets – Byers Has About Finished Oak and 8th Street Contracts, *Copper Country Evening News*, August 7th, 1906, p. 6.

33. Final Rush On – Blome Company Increases Number of Men Employed on Paving - 6th Street is Now Paved Past Intersection of Oak Street and Good Progress is Being Made – Portland Street is Being Graded, *Copper Country Evening News*, August 31, 1906, p. 8.
34. Rain Affects It – Portion of Sixth Street Pavement to Be Relaid at Once – May Finish 6th this Week – At Present Rate Men Will Be Enabled to Start Operations on Portland Street Next Week – Portion of Oak Street Creosoted Pavement Will Be Relaid, *Copper Country Evening News*, September 5th, 1906, p. 6.
35. Extra Force of Workmen on Scott Street – Portland Completed and All Work Will Be Finished Next Week, *Copper Country Evening News*, September 21st, 1906, p. 8.
36. People Complain on College Ave. Paving – Kicks Are Being Registered on Creosoted Block Pavement, *Copper Country Evening News*, June 23rd, 1906, p. 2.
37. Barnard Is Here – Creosoted Wood Pavement Man Talks on Houghton Pavement – Sand Was Swept off too Soon – Shows Letter from Government Inspector in New Orleans Which Shows Blocks Have Been in Use 35 Years, *Copper Country Evening News*, June 25th, 1906, p. 8.
38. Paving Trouble – College Ave. Work Taken up at Council Last Night – Street Will Be Alright Soon – Time Must Be Allowed for Sand to Work in Between Cracks and it Will Then Be Solid, *Copper Country Evening News*, June 26th, 1906, p. 2.
39. Report Denied – Rumor Request Would Be Made to Pave 6th Street with Brick – Will Use Creosoted Blocks – Rumor Gained Currency from Fact Blocks Had Sprung on 8th – An Ideal Pavement When Properly Cared For, *Copper Country Evening News*, July 12th, 1906, p. 8.
40. Two Engineers – Will Confer With the Council as to Creosote – May Use Another Material – Engineer Dutton of Minneapolis Sent for – Engineer Beehler Here – Conference Will Be Held, *Copper Country Evening News*, July 19th, 1906, p. 8.
41. Shumaker is Emphatic – Best Interests of Village to be Served in Paving Trouble – Beehler Also Talks – Says Whatever Ails Pavement is Due to a Local Condition – Talk of Using Granitoid for Creosoted Wood if Adverse Reports Are Made, Dutton Here Tomorrow to Make Investigations, *Copper Country Evening News*, July 20th, 1906, p. 8.
42. Granitoid on 6th Street – Substituted for Creosoted Wood, the Original Material – Meeting Held this Afternoon – James J. Byers Gives Up His Contract and the New Work is Awarded to Blome & Company – Village Will Save Several Thousand Dollars, *Copper Country Evening News*, July 24th, 1906, p. 8.
43. Meeting Minutes, Red Jacket Village Council, N. F. Kaiser, Village Clerk, July 24th, 1906.
44. Raise Up Again – More Trouble with Creosote Block Pavement on Oak Street – Something Must Be Done – Rain and Cold Work Havoc With the Material, *Copper Country Evening News*, August 27th, 1906, p. 8.
45. End of Paving – All Operations in Red Jacket to be Completed Tonight – Some Delay Was Experienced – Cement Which Was Expected Yesterday Morning Did Not Arrive Until the Afternoon, *Copper Country Evening News*, September 29th, 1906, p. 8.
46. Will Finish All – R. S. Blome Co. Expects to Wind Up Its Work Within 10 Days – Firm has About 800 More Feet to Lay on Portland Street and 1,400 More on Scott – Will Hustle Operations on Both Thoroughfares, *Copper Country Evening News*, September 15th, 1906, p. 8.
47. R. S. Blome's Men Leave – Some Depart for Other Points to Work, May Extend Vote of Thanks, *Copper Country Evening News*, October 8th, 1906, p. 8.
48. A Big Contract – The R. S. Blome Company Will Pave The Town of Gary, Indiana – Work Amounts to $200,000 – Streets of Steel Corporation's New Town Will Be Paved With Granitoid, 6th Street Will Be Completed This Month, *Copper Country Evening News*, August 8th, 1906, p. 8.
49. A Big Contract – R. S. Blome Co. Gets a $100,000 Paving Job in Washington, D. C. – Also Has Other Outside Work – Firm Was Awarded $75,000 Contract in Michigan City, Ind. Last Week and Is Now at Work Carrying Out Large Contract in Gary, Ind., *Copper Country Evening News*, September 19th, 1906, p. 8.
50. A Busy Company – R. S. Blome Company Has Many Contracts for Paving with Granitoid – Use Material in Chicago – Granitoid is to Be Used at Several Points Throughout the Windy City, *Copper Country Evening News*, October 2nd, 1906, p. 8.
51. *Which Pavement Shall We Select?* Rudolph S. Blome Company, Chicago, circa 1910, [DeGolyer Library Ephemera Collection, Trade Catalog #506, Southern Methodist University, Dallas, Texas].
52. Dorr, J. A., and D. F. Eschman. *Geology of Michigan*, The University of Michigan Press, Ann Arbor, Michigan, 1970.
53. Gillette, H. P., and C. S. Hill. *Concrete Construction – Methods and Cost*, Myron C. Clark Publishing Co., New York, 1908.

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