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## A RAILROAD GEOLOGIST LOOKS AT LIMESTONE AND DOLOMITE

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### ABSTRACT

Limestone and dolomite production is of significant importance to the Baltimore and Ohio Railroad. Except for coal, more tons of limestone and dolomite are moved by the Railroad than any other mineral raw material. In the territory served by the Railroad, these materials are produced from every geologic system from Cambrian through Pennsylvanian. Some of the operations produce premium stone acceptable for high-specification steel and chemical use; at others, the stone finds application as aggregate materials and for cement manufacture. The Railroad is interested in seeing continued production from the operations it now serves, and in serving operations in a way mutually beneficial to the Railroad and to the producer. In working with producers, the importance of geologic knowledge in prospecting and development of deposits has been clearly recognized. In turn, knowledge of the economic and technological facets of production and consumption is needed for the geologists to participate with maximum efficiency.

Limestone and dolomite are important commodities, as shown by the fact that the aggregate tonnage of carbonate-rock production is enormous, exceeding the tonnage of any metallic ore mined or quarried in the United States, and being exceeded in gross tonnage only by coal, sand and gravel, and water. No other rock materials are as important to industrial life as limestone and dolomite.

It is hoped in this presentation to explain the Baltimore and Ohio's interest in these rocks, to call attention to deposits in the territory served by this Railroad, and to describe briefly some examples of geological activity associated with the Railroad.

## BALTIMORE AND OHIO RAILROAD INTEREST AND PARTICIPATION

A railroad's interest in limestone and dolomite may be surprising. Nevertheless, the Baltimore and Ohio Railroad has a very distinct interest in these materials; it plays an important and necessary role in their supply and distribution. Two important segments of industrial United States are served, namely, the segment which includes the limestone and dolomite-consuming industries, and the segment representing the important sources of these two materials. For those not well acquainted with the Baltimore and Ohio System, a few points of interest seem worthy of mention. Chartered in 1827, it is the oldest railroad in the nation. It was originally conceived to connect the Atlantic Seaboard at Baltimore with the Ohio River at Wheeling, West Virginia, thus the corporate name. Through construction and acquisition, the System now consists of approximately 6,000 miles of mainline right-of-way, covering an important belt from the midwest to the mid-Atlantic.

Limestone and dolomite mean different things to different people. To a railroad, these products are important chiefly because they mean carloads of freight, and also because they are raw materials necessary for producing other items that move by rail, such as steel, cement, and chemicals.

The lines of the Railroad cross limestone or dolomite from every geologic system of the Paleozoic except the Permian; eleven different formations are being actively quarried or mined. More significant to the ultimate goal of hauling freight, the Company directly serves some 20 important stone-producing quarries or mines, some of which also produce lime, plus three cement plants supplied by nearby stone deposits.

That limestone and dolomite are important to the Baltimore and Ohio Railroad is also shown by the freight traffic realized from them. In 1963, for example, approximately three million tons of fluxing stone and one million tons of crushed and broken stone, primarily limestone and dolomite, were moved. In addition to the stone materials are the upgraded products that depend almost entirely on limestone or dolomite, e.g., cement and lime. Movement of these two commodities for 1963 was about two million tons.

The company, of course, wants to see the present plants continue to produce, and to expand. As the need develops for new quarries or mines in the territory served, it also seeks to locate those operations on-line. To this end, the Railroad wants to work with present and potential producers, and to help them with development problems, including those of a geologic nature. Although the Baltimore and Ohio Railroad is fortunate in serving some important limestone and dolomite producers, other equally important producers are located on competing lines and still others are not dependent on rail service of any kind. Therefore, it behooves the company to stay competitive and to help its shippers stay competitive in any way it can.

Within the Baltimore and Ohio Company, as with all railroads, the responsibility of locating revenue-producing plants rests with an Industrial Development Staff. Duties are naturally varied, according to an industry's need, but all are directed toward assisting and encouraging the industry to locate and expand on the Railroad. Therefore, it is necessary for the company to keep informed as to site availability, i.e., where industrial plants can be built. This, naturally, includes the location of quarry or mine sites, their development, and where desired, continuing professional assistance.

## LIMESTONE AND DOLOMITE DEPOSITS

The important limestones and dolomites along the Baltimore and Ohio Railroad include formations of the Cambrian and Ordovician Systems in the Shenandoah Valley of Virginia and West Virginia, the Silurian in western Ohio and northeastern Illinois, the Devonian in central Ohio, the Mississippian in southern

Indiana and northern West Virginia, and the Pennsylvanian in western Pennsylvania and eastern Ohio.

The largest shipments are from the Shenandoah Valley region. There the quality of the stone and its value to the Railroad are indicated by the presence, within a radius of less than 20 miles, of six limestone and three dolomite operations, all served by the Railroad. Several of the operators are also substantial producers of high purity lime. In addition, one mine produces stone exclusively for making cement.

In the Shenandoah Valley, the Tomstown Dolomite of Cambrian age and the Mosheim Limestone of Ordovician age have supplied open-hearth, blast-furnace fluxing stone and lime to steel mills of both the Pittsburgh and mid-Atlantic regions for many years. Of the two formations, the larger shipments are from the Mosheim, which is truly a high-calcium limestone, equivalent to any in the east. Although the term New Market is gaining acceptance for this formation, producers and consumers prefer the name Mosheim, as signifying quality and consistency. The Mosheim ranges from a few feet to over 200 feet thick. Controlled by the structure of the Appalachians, it has a regional dip toward the southwest. However, because of severe folding and faulting, there are numerous variations and reversals of this regional structure and, on a geologic map, it appears as a sinuous and often interrupted band. In spite of resulting quarrying difficulties, however, purity of the stone and its location within economic shipping distance of important steel centers make it attractive. Premium beds in the formation commonly test over 98 per cent total carbonates. Some operations have consistently produced open-hearth fluxing stone that tests over 97.0 per cent calcium carbonate and 1.5 per cent magnesium carbonate, with less than 1.0 per cent silicon dioxide, 0.05 per cent sulphur, and 0.005 per cent phosphorus.

Many operators in the region are turning to underground mining of this stone, for several reasons. Certain zones in the Mosheim are exceptionally pure, so that selective mining results in a consistency of product unhampered by contamination of overburden or dilution by stone of lesser purity. Structural conditions may also encourage mining. For example, where the stone dips more than 30 degrees, quarrying quickly depletes the near-surface stone and stripping of the overlying impure formation soon becomes excessive. In such situations, mining greatly increases the economically recoverable reserves. A mining operation is also more independent of weather conditions than is an open pit. Problems often associated with mining, such as changes in structure, roof control, and drainage, are obviously surmountable, as evidenced by successful operations. Projections of formational structure and quality, based on regional geologic knowledge, some theory, and test cores, have been remarkably accurate to date.

Dolomite production in the Shenandoah Valley region is confined to a small area near Harpers Ferry, West Virginia. From this area, both high-grade dolomite and dolomitic lime have been shipped for many years, primarily for use by the steel industry. This premium dolomite is part of the Tomstown Formation, the lowermost carbonate rock of Cambrian age; up to 150 feet of thickness is quarried. As with the Mosheim Limestone, the regional dip is to the southeast, but it, too, varies locally, and in places is almost horizontal. Chemically, the dolomites are almost pure. They commonly test over 55 per cent calcium carbonate and 43 per cent magnesium carbonate, with less than 1 per cent silicon dioxide, 0.02 per cent phosphorus, and 0.01 per cent sulphur.

Elsewhere in the East, i.e., outside the Shenandoah Valley, stone production along the Baltimore and Ohio Railroad is largely for uses that do not require such high chemical purity. This type of stone accounts for a considerable tonnage quarried in neighboring Maryland for making aggregate, portland cement, and lime.

Moving west from the Shenandoah Valley and up the geologic column, the Silurian dolomite of late Niagaran age in northeastern Illinois is an important

source of stone for high-quality lime, fluxing stone, and aggregate. This stone is used primarily by markets in the Chicago area. Interesting and rather complex reef structures are common in the region; purity of the stone tends to decrease with increased distance from the reef centers. The upper Niagaran dolomites are also important in northwestern Ohio, where they have long been known for their purity. Good quality stone, yet to be developed, lies adjacent to the Baltimore and Ohio Railroad in that area. Extensive deposits of Niagaran dolomite are also known in the southwest part of Ohio, including locations along the Railroad, where there is evidence of high-quality stone. Older Silurian rocks are also an important source of limestone in southwestern Ohio. Here, in a relatively small area in the Miami River Valley, the lower Silurian Brassfield Limestone is an important source of blast-furnace stone, lime, cement, and aggregate.

Other operations along the Baltimore and Ohio Railroad are primarily commercial-stone producers. Rock formations utilized include the Columbus Limestone of Devonian age near Sandusky, Ohio, and the Greenbrier Limestone of Upper Mississippian age near Morgantown, West Virginia. Mississippian limestones are also important sources of cement rock and aggregate along the Railroad's line in southern Indiana near Mitchell, where selected beds qualify as high-calcium stone.

The most important Pennsylvanian limestone is the Vanport, which is widespread in eastern Pennsylvania and eastern Ohio. At one time it was the source of important shipments to steel mills of the region. Now, however, because the stone is of marginal purity and relatively thin, and therefore costly to mine, most of the operations are abandoned.

Structurally, the limestone and dolomite deposits along the Baltimore and Ohio Railroad range from complex to simple; stratigraphically, they range from Cambrian through Pennsylvanian; and in quality, they vary from common aggregate to premium stone of chemical purity. Although all important regions of good limestone and dolomite along the Railroad have been reasonably well defined, there are still localities where good stone is available and awaiting development.

#### DEPOSIT VALUE

The mere existence and availability of acceptable stone does not assure a successful operation; competition is ever present. It exists not only among operators in a given locality, but also among sources from widely separated localities. For example, producers of the Shenandoah Valley limestone encounter competition from stone of the Bellefonte region of Pennsylvania, as well as from stone delivered by water to Great Lakes ports for land shipment to steel-producing centers.

What, then, makes a stone deposit valuable—what makes it competitive? The criteria are almost wholly economic, not geologic. The stone must answer a processing need, at a cost that allows a profit to all who must handle it. Using fluxing stone as an example, there are three important participants: the producer, the carrier (rail, water, or highway), and the steel company. Because most stone deposits are not immediately adjacent to points of consumption, transportation are a critical facet of over-all cost. Often they are greater than the stone costs at the mine or quarry. Therefore, rail-based deposits are of value to the producer, as well as to the railroad, only if the stone can be delivered to the consumer at an attractive price. To this end, both are constantly striving to increase operating efficiency. Success in this respect has been remarkable, for stone prices at the crusher and at destination have not increased in proportion to total manufacturing costs.

#### GEOLOGICAL CONTRIBUTIONS

To encourage development of natural resources that contribute to its freight revenue, the Baltimore and Ohio Railroad has had a geologist on its Industrial Development Staff for many years, probably as long as any other eastern railroad.

Unlike many of the western lines, the Company does not own large blocks of land. Therefore, there is no formal or continuing program of exploration, other than seeking to assist consumers or producers in their search for acceptable deposits.

Information is obtained from many sources. State or Federal surveys and university or college reports are valuable sources for many areas. These contributions often form the basis for additional office or field investigations where the place value of a deposit seems promising. In addition, investigations may be prompted by an inquiry from an industry; they can be made for a community interested in knowing about their raw materials; or they can be self-initiated in anticipation of a future need.

In any given area, geologic knowledge naturally is increased by working with a shipper. Information obtained in this matter is always held in strict confidence, just as would be done by any consultant, until such time as the shipper or potential shipper has no further interest in secrecy. This practice conforms to established professional ethics and it is also simply good business. To date, the Railroad has never been guilty of violating a confidence.

Geologic activity on the Baltimore and Ohio Railroad can be simply summarized as being that which is directed toward developing information that will be helpful to any minerals-oriented enterprise. It involves quality and availability; or, more simply, where? how good? and how much?

Almost without exception the geologist in any company producing industrial minerals must expect not to confine his activities to his specialty. He will almost certainly be involved in problems of end use, marketing, transportation, production costs and practices, real estate acquisition, depletion allowance, and, no doubt, many others. This is also true on the Railroad. Nevertheless, many instances have demonstrated the need and value of geologic knowledge and its application. Some simple examples of this application for shippers along the Railroad illustrate this point. A most obvious contribution, of course, is in exploration for new deposits or extension of existing deposits. This service has been frequently rendered and proved of valuable assistance to operators, especially the smaller ones, who have sought geological advice prior to option or purchase of untested property.

Other examples of the value of simple geologic assistance include that of an operator who expanded his quarry a short distance around a hill. The new face, however, produced stone unacceptably high in silica. Investigation revealed that, in the move, a regional dip, not readily detectable, had brought overlying impure beds, similar in appearance, down into the quarried zone. Fortunately, this mistake was relatively easy to correct.

In another instance, rail-delivered material sent by a shipper was being rejected for chemical reasons. His stone had previously been acceptable and he hadn't moved his quarry site, yet his sales and railroad freight were threatened. Fortunately, a simple geologic investigation, coupled with prior knowledge of the formation, indicated that there were vertical and lateral chemical changes in the deposit. Checking confirmed the suspicion that operations at one end of the quarry were moving into a slightly impure facies. Raising the quarry floor about 5 feet made the product acceptable. This action saved the operation, and the shipper. Additional core drilling will define the extent of the impure facies.

At one time the Railroad was able to help increase a shipper's sale of agricultural lime by suggesting that he blend high-calcium stone with marginal stone at his main quarry and, by calculation, determine the varying amounts needed to realize different calcium-carbonate equivalents. This action helped a good shipper and also netted the company a few more tons of freight. Other geological activities include spotting, logging, and interpreting cores; estimating reserves; defining and mapping the extent of acceptable stone; and determining structure in preparation for a mine or quarry layout.

These very simple examples illustrate ways in which a railroad guided by a

knowledge of geology can serve its customers. They also demonstrate the value of having geologically-trained personnel in any operation producing industrial minerals. Possibly they suggest the value of a geologically trained man with polyfunctional responsibility.

As a service to the limestone industry, the Baltimore and Ohio Railroad, some years ago, called attention to high-calcium limestone in its territory by printing and distributing a comprehensive description of these deposits for the entire System. This report was very well received and serves many geologists and producers as a valuable reference on the subject of limestone. An earlier publication dealt similarly with salt. These are examples of the geologically-oriented service functions of the Baltimore and Ohio Railroad.

#### RATES

Any discussion of the Railroad's interest in limestone and dolomite would be incomplete without some mention of rates. In considering the place value of a deposit, a geologist is hampered unless he has an intelligent estimate of costs involved in moving the stone to market. He should be able to arrive quickly at some reasonable estimate of such costs. In many cases, however, such quick estimates, even by the Railroad, are not possible.

Estimating, proposing, and establishing rail rates is a very complex procedure; it is really a special branch of railroading which cannot be described in a few words. Any rail rate that is established must be published and, by law, all shippers of that commodity are then eligible for that rate between the points described in the published tariff. The Interstate Commerce Commission keeps careful watch on this. Therefore, if a shipper wants a quotation on rates between points where movements are already being made, it is a fairly simple matter; such information is available through his own traffic department or by inquiry to his contact on the railroad involved. Unfortunately, however, rate information is not so simply available if the potential movement is between points where there are no established shipments. This requires special processing, including cost studies and checking with connecting lines prior to quoting a proposed rate, that is, a rate the railroad would be willing to propose if the shipper actually moved the commodity in the amount stated, and if the ICC approved. Obviously, these brief comments oversimplify the situation, but the point is that rate making is not simple and cannot, in fairness, be made "off the cuff." Such action could be detrimental to both the shipper and the railroad.

#### THE FUTURE

No discussion of limestone and dolomite would be complete without some mention of reserves and future development of these essential commodities. The first rule is that everyone must recognize that all deposits of high-quality carbonate rocks are finite, even along the Baltimore and Ohio Railroad; they are not replenishable. They may thin out, change in quality, extend too deep, or be abandoned because of competition for available land space, especially in urban centers.

We are not yet ready to push the panic button, however, for with the improvements of technological skills in production, and with increasing geologic knowledge, extensions of existing deposits and recovery of heretofore uneconomic deposits will be realized. The best place to look for new sources of stone is generally in formations already known to contain premium-quality stone, most of which have been reasonably well defined, especially in the East. Within the Baltimore and Ohio service area, for example, there are places where untouched high-purity stone is known and is believed to be economically recoverable. As markets develop and economics dictate, new operations will become an actuality. The Railroad hopes and expects to continue to serve as an important member of the team that makes limestone and dolomite available to the many uses for which they are suited.