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REFRACTORY CLAY RESOURCES OF ILLINOIS

W. Arthur White

ABSTRACT

This report is designed as a guide to prospecting for refractory clays in Illinois. Refractory clays are known to occur in the Caseyville, Abbott, Spoon, Carbondale, and Modesto Formations of the Pennsylvanian Series and in the Cretaceous Series of rocks.

The clays and shales are classified into four levels of refractoriness—super duty, P.C.E. 33 and above; high duty, P.C.E. 31 to 33; medium duty, P.C.E. 29 to 31; and low duty, P.C.E. 15 to 29.

INTRODUCTION

At present, clays are being mined for refractory purposes in four counties: Grundy, LaSalle, Massac, and Scott. The clays are used for making refractory brick, shapes, and cements, for a bonding material in synthetic molding sands where refractoriness is desired, for linings where refractory monolithic walls are needed, and for various other uses.

This report may be used as a guide to further prospecting for refractory clay and as an aid in industrial zoning problems of the community.

GEOLOGY

Most of the refractory clays in Illinois have been mined from the Spoon and Abbott Formations of the Pennsylvanian Series and from rock deposits of the Cretaceous Series in Union County. Other Pennsylvanian formations that contain refractory clays are Caseyville, Carbondale, and Modesto; and other Cretaceous deposits in Massac, Pope, Pulaski, and Alexander Counties also are a source of refractory clays.

MINERALOGY RELATED TO GEOLOGY

Work with recent sediments (Grim and Johns, 1954; Brown and Ingram, 1954) indicate that kaolinite is more abundant near shore than farther out in

a depositional basin. Recent work by Parham (1962), Groot and Glass (1960), Waage (1961), Grim et al. (1957), and Pryor and Glass (1961) suggests that in ancient sediments, kaolinite-rich sediments occur near the periphery of a sedimentary basin, and that the nonrefractory clay minerals — illite, montmorillonite, chlorite, vermiculite, and mixed-layer clay minerals, increase in relative abundance with increased distance from shore. However, this is true only if the contributing source area originally contained kaolinite.

Most of the outcrop areas of the clays of the Caseyville, Abbott, and Spoon Formations and the Cretaceous deposits in Illinois, contain enough kaolinite to be considered refractory, whereas in subsurface areas they may not. Usually the shales of the Pennsylvanian formations are less refractory than the closely associated clays. In addition to these formations, the underclay below the Danville (No. 7) Coal of the Carbondale Formation in Grundy County and the underclay below the Chapel (No. 8) Coal of the Modesto Formation that extends along the outcrop belt starting east of Paris in Edgar County and continuing northwest to west of Danville near Oakwood in Vermilion County, contain enough kaolinite for low heat-duty refractories.

MINERALOGY AND REFRACTORINESS

The refractoriness of clay materials in Illinois tends to be controlled by the quantity of kaolinite in relation to the other minerals. The more kaolinite, the more refractory the clay material tends to be. Large quantities of quartz may increase or decrease the refractoriness of a clay material. The particle size of the quartz also may influence the refractoriness of a clay material — the larger the particle size the more refractory the clay material. Large particles leave less surface area to enter into the reaction between the clay particles and the quartz. However, a mixture of kaolinite and quartz will be less refractory than either one alone.

In some sandy clays, where the nonrefractory clay minerals and kaolinite are about equal and where the quartz content is sufficiently great, the quartz may contribute to the refractoriness.

Pyrite, siderite, gypsum, and lime will tend to reduce the refractoriness of clay materials and these minerals are most effective in lowering the refractoriness if they are finely disseminated throughout the clay mass. Large crystals cause either iron or lime pops in the fired brick. Iron pops occur during the firing, but lime pops occur after they have been fired and are allowed to stand in the atmosphere.

If the clay is allowed to weather, any pyrite present will oxidize forming ferrous sulfate and sulfuric acid. The sulfuric acid will react with any lime that might be present to form gypsum. These soluble salts will reduce the refractoriness of the clay since they would be distributed throughout the clay mass by the addition of water to form the ware. Such weathering will change the plastic properties of the clay by making the clay more plastic which, in turn, will require more water for plasticity. The shrinkage of the final product will also be greater.

The refractoriness of the clays will vary from one geographic location to another and from one stratigraphic unit to another in any given formation. These differences may be due to variations in clay mineralogy, to the nonclay mineralogy, or both. These lateral variations, particularly in the nonclay components, can change over distances of only a few feet. Any component can vary markedly in the vertical direction.

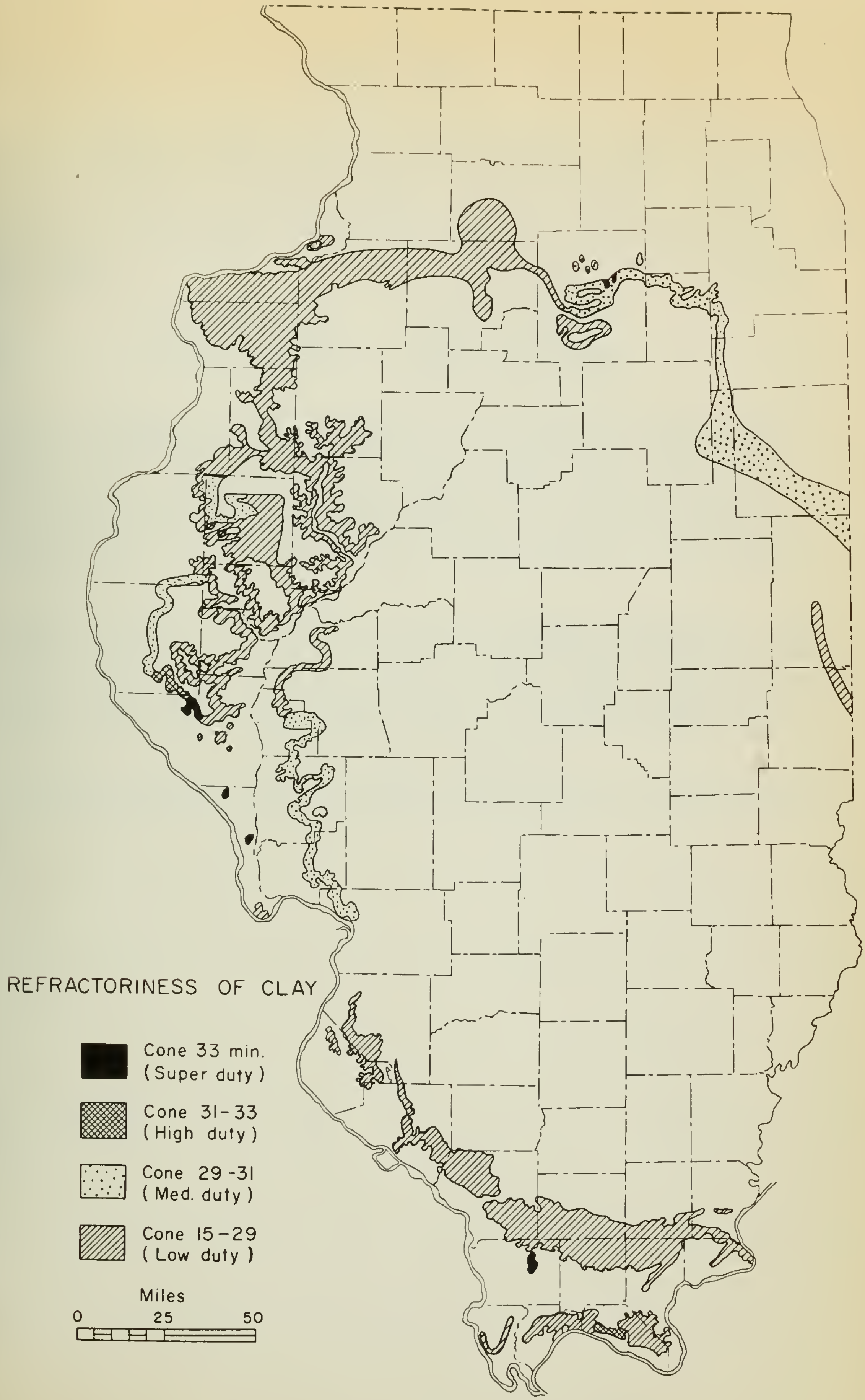

Fig. 1 — Outcrop areas of refractory clays in Illinois

CLASSIFICATION

The American Society for Testing Materials has classified refractory clays according to their ability to withstand heat. The refractoriness of the clay is measured in pyrometric cone equivalents (P.C.E.). A cone of clay and standard cones are heated together and the fusion is compared. When the clay melts its refractoriness is recorded as, for example, P.C.E. 30, above 30, 30-31, or below 30. The uses are (American Society for Testing Materials, 1958):

Super heat duty	P.C.E. 33 minimum
High heat duty	P.C.E. 31 minimum
Medium heat duty	P.C.E. 29 minimum
Low heat duty	P.C.E. 15 minimum

The information (fig. 1) showing the locations for refractory materials was taken from published reports (Purdy and DeWolf, 1907; Parmelee and Schroyer, 1921; Rolfe et al., 1908; Lamar, 1931; Willman and Payne, 1942; Lamar, 1948; Parham, 1959; Parham, 1960; White and Lamar, 1960; and Parham, 1961), and from unpublished data. The areas for which no P.C.E. values exist are filled in from the mineralogical data and from the geological data.

In areas where only one P.C.E. value is known, that class is used. In areas where several P.C.E. values are known and where the majority falls in the maximum class, the whole area is given to that class. If one or two values are above the majority, the area is indicated by the symbol of the majority and a dot indicates the maximum class. In any area some samples may be found which may fall below the class indicated.

Anyone interested in any of these areas may write to the Illinois Geological Survey and obtain more specific information.

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