

Physiographic Subdivision for Engineering Purposes*

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•THE planning, design and construction decisions rendered by highway engineers are influenced, to greater or lesser degree, by the geology of the route or site. A number of important predictions can be made on the basis of generalized interpretations of the distribution of soils and rocks, their topographic expression and climatic environment, and the kinds of physical problems customarily associated with the setting. The greater the organized content of highly relevant experiences which the engineer can input into these judgments, the greater the probability that subsequently revealed details will fit the generalizations.

The hypothesis of the comprehensive National Cooperative Highway Research Project study entitled "Regional Factors Influencing Highway Design and Construction" is that the distribution of surface soils, mineral aggregates and certain highway engineering problems can effectively be generalized within physiographic units.

ELEMENTS OF PHYSIOGRAPHY

In simple view, physiography permits subdivision into areas of contrasting or distinctive topographic expression. Such divisioning is effected by an examination of three geomorphic control factors; viz., structure, process, and stage. In effect, this is equivalent to stating that the topographic expression is a function of the geologic parent material, the geomorphic processes acting, and the time and climate of action (1). These factors are highly relevant to landscape classification for engineering purposes, although they are not readily quantified.

The system of physiographic unit categorization initially examined in the project was a modified version of the Woods-Lovell classification (2). In this system, the United States is divided into 20 Provinces and 96 Sections. Each physiographic unit was examined with respect to the "homogeneity" or "uniqueness" it possessed. In several cases, a finer or more detailed divisioning system was proposed. In addition, the criteria for physiographic unit subdivisioning was reviewed in order to better understand the intrinsic capabilities of these units to serve as a kind of geographic filing system for engineering experiences.

As previously suggested, the specific highway engineering factors investigated within the United States were availability and problems of mineral aggregates; surficial soil distribution on the basis of origin and generalized texture; and related soil problems, e.g., high volume change, frost susceptibility and landslides.

To illustrate the logic of the study approach, several highway engineering problems are discussed in the paper. Only one of these, the distribution of crushed aggregates within the physiographic units of the Interior Low Plateau Province, is briefly described here.

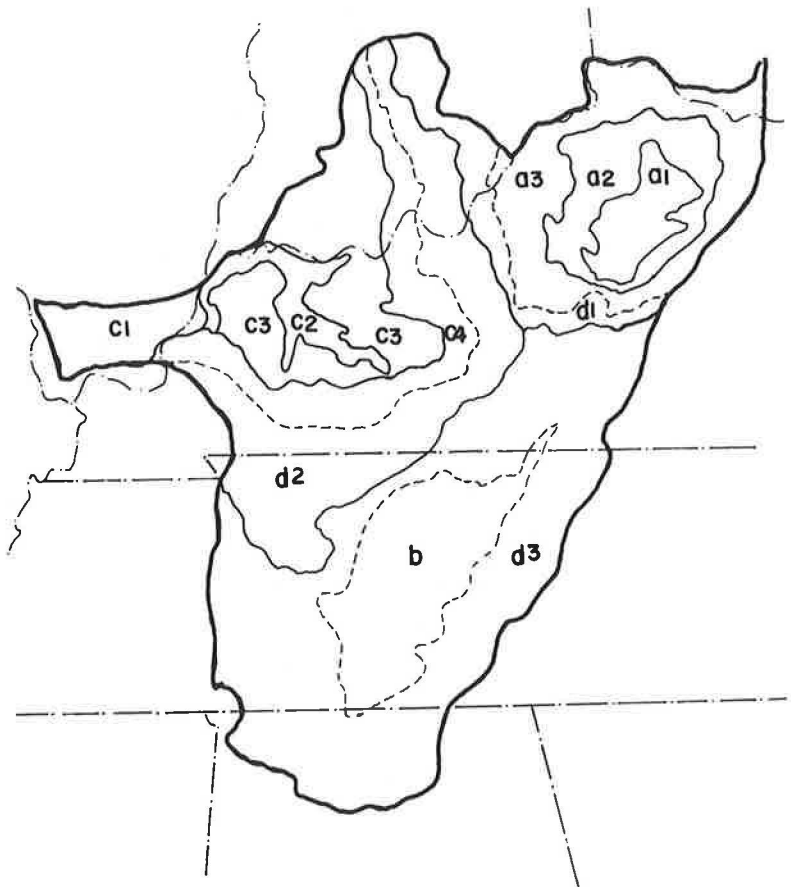
INTERIOR LOW PLATEAU PROVINCE

Major Characteristics

The Province has four recognized Sections (2): (a) Blue Grass; (b) Nashville Basin; (c) Shawnee Hills; and (d) Highland Rim. The Province is generally surrounded by

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NOTE: ALPHA-NUMERIC CODE KEYED TO TABLE 1

Figure 1. Interior low plateau physiographic unit diagram.

TABLE 1
CORRESPONDENCE OF PHYSIOGRAPHIC UNITS AND BEDROCK

Physiographic Section/Subsection	Major Bedrock Type and Age
(a) Blue Grass	
1. Inner Blue Grass	Limestone; Lower Ordovician.
2. Eden Shale Belt	Shale; Ordovician (Eden).
3. Outer Blue Grass	Limestone and Shale; Upper Ordovician and Lower Silurian; Thinly Bedded.
(b) Nashville Basin	Limestone; Lower Ordovician; Some Cherty.
(c) Shawnee Hills	
1. Southern Illinois Loessial Area	Sandstone, Shale and Limestone; Mississippian; Loess Cover.
2. Island Hills	Sandstone, Shale, Coal and Underclay; Pennsylvanian; Alluvium.
3. Indiana-Kentucky Coal Fields	Sandstone, Shale, Coal and Underclay; Pennsylvanian.
4. Mammoth Cave Plateau	Sandstone, Shale and Limestone; Mississippian.
(d) Highland Rim	
1. Knob Hills	Shales with Sandstone (Limestone) Cap; Mississippian-Devonian.
2. Western Pennyroyal Limestone Plain	Limestone; Mississippian.
3. Kentucky-Tennessee Eastern Pennyroyal	Shale and Limestone (Variable Quality); Mississippian.

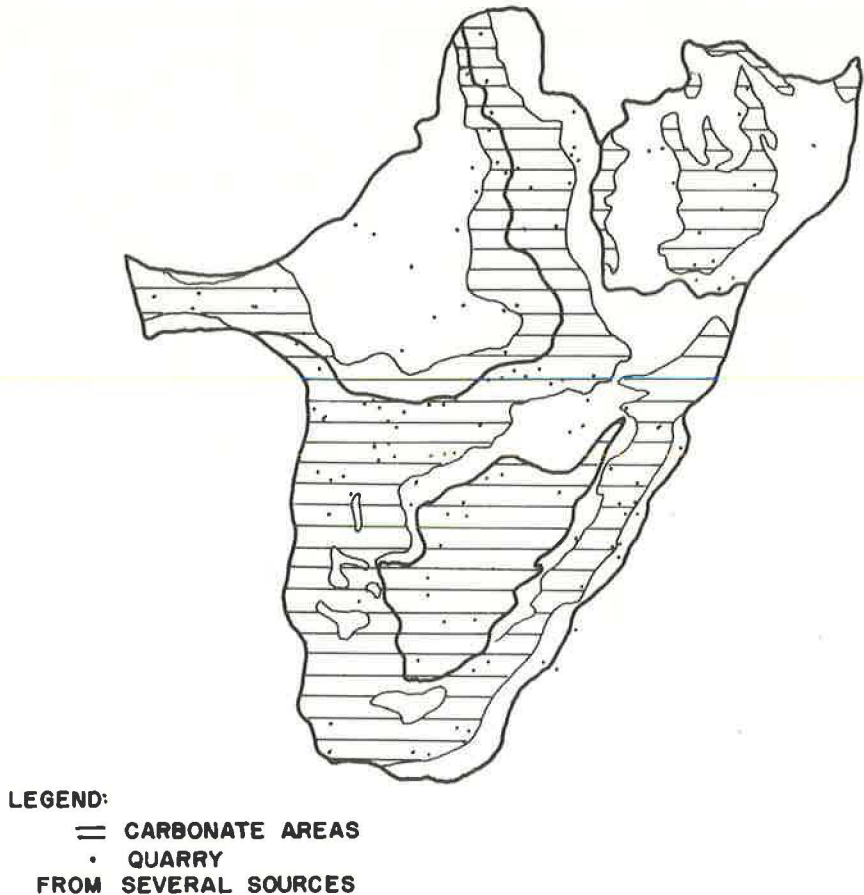


Figure 2. Distribution of major carbonate aggregate sources in the interior low plateau province.

topography of lesser maturity, and contains a series of plateau forms developed on slightly dipping Paleozoic sedimentary strata. The soils are predominantly residual, with small areas of aeolian and alluvial materials. Glaciation immediately to the north altered the topographic expression in a number of ways, particularly through influence on regional drainage.

The bedrock geology conforms to three major structural features; viz., the Ozark Dome to the west, the Illinois Basin to the northwest, and the Cincinnati Arch and Nashville Dome in the east. Erosional processes have operated on the eastern element to produce two topographically low areas: the Blue Grass of Kentucky and the Nashville Basin in Tennessee. The older rocks of the Province lie near the surface here, and escarpments or cuestas, formed of successively more youthful sediments, ring them.

TABLE 2
SUMMARY OF CRUSHED STONE AVAILABILITY WITHIN THE
SUBSECTIONS OF THE INTERIOR LOW PLATEAUS PROVINCE

Availability Rating		
Abundant to Good	Good to Fair	Poor to Nonexistent
a1	d3	a2
b		a3
c1		c2
c4		c3
d2		d1

Subdivision Logic

The geomorphic control factor of structure exercises a dominant influence, and the regional topographic expression is obviously correlated

to the lithology and attitude of the bedrock. Section boundaries are often marked by topographic contrasts; and, except for the northwestern portion of the Province, subdivision at the section level evokes little controversy among physiographers. On the other hand, the potential for mapping subsections of a higher order of topographic homogeneity is reasonably obvious.

A suggested system of subsections is illustrated in Figure 1. A key to the age and kind of sedimentary rocks is given in Table 1. No breakdown is needed for the Nashville Basin (b), while, even with the subdivision shown, the Kentucky-Tennessee Eastern Pennyroyal (d3) lacks the degree of homogeneity achieved for the other subsections.

The roughness of the terrain can be surmised from the type and age of the rock from which it was carved by destructional processes. Constructional features are largely limited to Shawnee Hills subsections (c1) and (c2). The limestone areas are generally more gently rolling than the sandstone ones, and exhibit abundant solution features.

Material of Construction (Aggregates)

Figure 2 is a mapping of the major sources of crushed carbonate rocks in the Province. The mapping is a composite interpretation of bedrock geology and quarry operations. A comparison of Figures 1, 2 and Table 1 shows that the physiographic subsections have strong predictive value with respect to the general availability of crushed stone resources.

SUMMARY

The basic hypothesis of the work is that cogent highway engineering design and construction factors can be generalized with respect to physiographic units. These units may then serve as a geographic filing system for engineering experiences. Table 2 illustrates the use of the concept for the factor of crushed aggregate availability in the Interior Low Plateau Province.

REFERENCES

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2. Woods, K. B., and Lovell, C. W., Jr. Distribution of Soils in North America. Section 9, Highway Engineering Handbook (Ed., K. B. Woods), McGraw-Hill, 1960.