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# URBANIZATION AND THE CHANGING LOCATION OF AGGREGATE PRODUCTION

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In this article we are concerned with the mining of building materials, primarily with sand and gravel, but also with clay and volcanic cinder. Admittedly, mining activities are seldom considered "urban." Yet, despite their omission from most texts on urban geography, we feel the importance of our concern with mining activities, that is, with aggregate production in and near urban areas deserves attention for at least two reasons. First, though employment in the aggregate industry is relatively small in local areas, "it is significant, because aggregates and the products made from aggregates are an essential part of the construction industry, and the rest of the construction industry depends on aggregate production as its starting point."[1] For example, an average, single-family residence requires about 114 tons of aggregate for the house, driveway, and yard; and yet another 73 tons are required for construction of public facilities for that home.[2] Second, because aggregates are bulky and low in value per unit of weight, they must, in most instances, be produced in close proximity to the area in which they are being used. As urban growth expands outward, the production of aggregates often leads to conflicting land uses near the rural-urban fringe.

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Our purpose, then, is twofold. First, by utilizing traditional models of urban land use we provide a means of explaining the changing location of aggregate production in and around urban centers. Second, we focus attention on possible future problems of expanding urban areas where land-use conflicts on the urban fringe and beyond may make the provision of aggregates more difficult.

Our approach employs basic models in urban geography as building blocks around which we generate a reasonable explanation of the locational pattern of aggregate production in an urban area. This essay not only demonstrates the utility of applying basic models to help understand urban spatial arrangements, but also explores a neglected topic of both economic and urban geography.

The geography of mining has been a somewhat neglected subfield of economic geography. In general, the geographic study of mining has been more descriptive than theoretical and has focused mainly on the production of major industrial materials, such as coal, iron ore, copper, aluminum and tin.[3] The environmental impacts of mining also have attracted the attention of some geographers.[4] However, the publication of several proposed models of mining location provides an encouraging sign of renewed interest.[5]

In searching for an explanation of the location of aggregate producers, the aforementioned studies, unfortunately, offer little guidance. The Russian studies, though interesting, offer no help toward explaining locational patterns in market economies. Indeed, only the work of Hay is of sufficient value to consider further in our context.

After lamenting the lack of a basic location theory for mining activities, Hay suggests that geographic variations in the costs of mining are a function of: (1) the nature and natural environment of mineral deposits and (2) the man-made and social environment of the mining operation itself. He argues that: "The geological and geographical characteristics of mining sites, their locations with respect to a market and the resultant transport costs together determine the joint aggregate supply curve of . . . mines to that market."[6]

Hay's model is instructive and provides a definite improvement over previous attempts to develop a theoretical model of mining location. Even so, it is not appropriate to our task. From it we could conclude that, because we are dealing with a low-value product that is very sensitive to variations in transportation costs, aggregate production will occur as close as possible to the market. However, numerous factors which tend to be especially sensitive in urban areas are not considered. Among these we would include the dispersed nature of the urban market for aggregate, competition from urban land uses, the role of zoning on the urban periphery, and a variety of environmental issues. Similarly, McCarty and Lindberg noted that:

> It is evident that for producers of some mineral products least cost locations will almost always occur at those deposits that are near markets. This situation may be anticipated wherever the products (1) occur almost everywhere in deposits that do not vary greatly in character, or (2) are heavy, bulky, or of low value per unit of weight. Sand and gravel usually are cited as good examples of commodities that have these characteristics.[7]

We do not reject the notion that aggregate production is a market-oriented activity, but we need to go beyond that generalization. We need to seek a model that explains not only where within an urban complex aggregate production is occurring, but also where it is likely to occur in the future. The best starting point, then, may be consideration of the bid-rent approach, ultimately coupled with constraints on aggregate production.

Well-known to both urban and economic geographers, the bid-rent model of land uses in and around urban areas seems attractive for our purposes, because it helps explain current land-use patterns and also offers clues to future land-use patterns associated with the expansion of urban areas. The classical presentation of the bid-rent approach, based on a monocentric city, was made by Alonso,[8] though many variations on the general theme have been orchestrated over the intervening years.

The central theme, of course, is that in an urban area only a limited amount of land is available for any given activity. Accordingly, land will be offered for various uses as a result of competitive bidding for sites by various land-using activities. Because accessibility to the urban area is considered essential, bid-rents are highest for the most central sites, those nearest the center in the monocentric model. Thus, land uses will be allocated for various sites according to the activities that offer the highest bid-rents for those sites. Functions unable to pay high rents will be pushed toward the urban periphery. For each major land-use category we can imagine a bid-rent curve that declines from a peak at the most central location to zero at

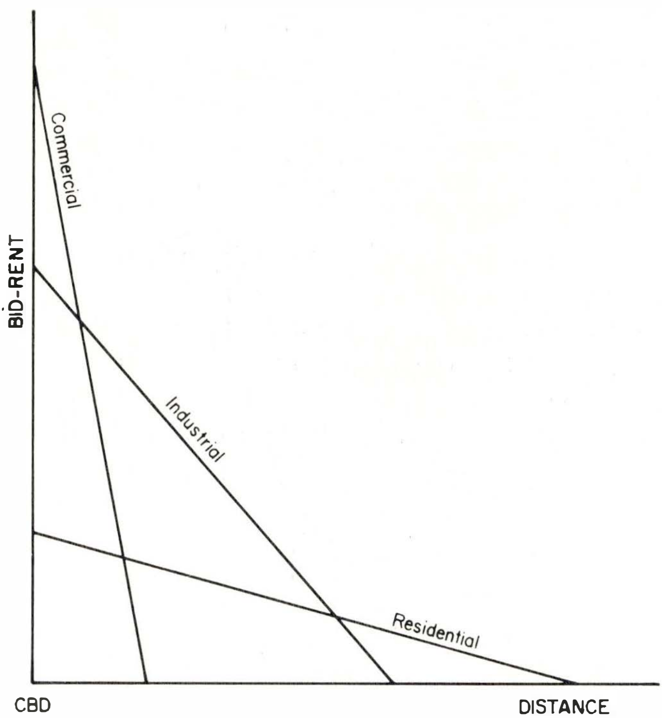


Figure 1.

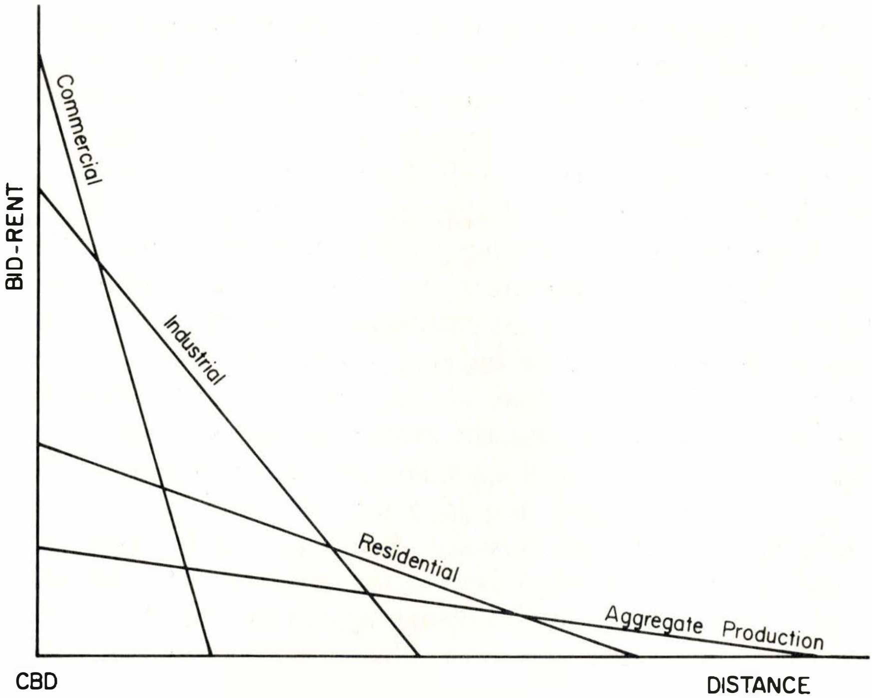


Figure 2.

some distance outward from the center, that distance depending, among other things, on the importance of accessibility (Figure 1). Of course, the bid-rent curve provides only a starting point, not a complete explanation of urban land uses.

Now, what does all this tell us about the location of aggregate producers in the urban milieu? First, it is apparent that aggregate producers will not be able to bid high rents for central locations; so we might imagine a bid-rent curve with a rather low gradient (Figure 2). All else being equal, we could argue that in the simple static model aggregate producers would locate in a concentric zone surrounding a similar zone of residential land-use, whereas commercial activities would dominate the central business district (CBD) and would be separated from the zone of residential land-use by an industrial zone.

Still looking at our simplified bid-rent model we can introduce some more realistic constraints. For example, as with all mining activities, it is essential that aggregate of a usable grade be available at sites within the production zone determined by bid-rent curves. Realistically, the zone is unlikely to be a homogenous source of aggregate; rather, production sites are likely to appear in clusters within the bid-rent production zone (Figure 3). Furthermore, local zoning ordinances may reinforce the clustering of individual producers around aggregate deposits within the bid-rent production zone.

The model is, of course, a static one; yet by introducing urban growth we can use the model to suggest what would happen to the location of aggregate producers over time. Obviously, urban growth would affect bid-rent curves, most likely by pushing them outward. Assuming that bid-rent relationships are maintained among the gradients for different land-use curves, we should find aggregate producers being outbidded by other land uses in established production zones and being forced to seek newer sites in more distant zones. Though he was speaking of manufacturing, the following remark by Barlowe is also appropriate to our case:

> Factory owners sometimes find that their properties have higher market and rental values for other uses than for their current uses. In these cases, it may be good business, if the operators' moving and supersession costs are not great, to sell or rent their properties and move their industries to new sites where they can benefit from lower land costs.[9]

Rising prices and land-use conflicts become more likely as suitable sites become scarcer around the expanding urban periphery. Hence, the very urban growth that generates the need for aggregates also complicates attempts to supply them. Thus, a dynamic model must also include a consideration of the environmental pressures generated by new urban residents in areas immediately adjacent to aggregate production districts.

As the metropolitan area expands, new suburban growth begins to surround aggregate production sites. This, in turn,

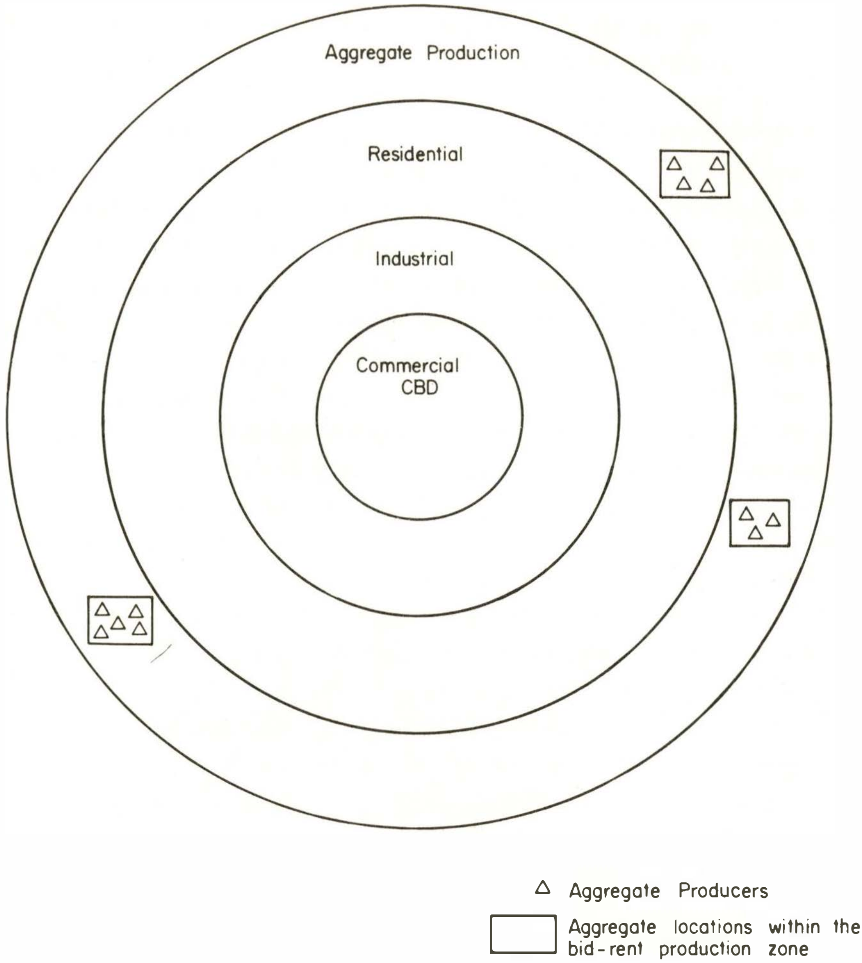


Figure 3.

provides a population base for applying social and political pressure to local government for restricting and further regulating aggregate production. Unlike the situation with airports and some other environmentally damaging land uses, there are few, if any, directly perceived benefits from aggregate production. Where land-value pressures alone have not been successful in driving out aggregate producers, social and political pressures often have.

## Aggregate Production in Los Angeles: An Example

In order to view the location of aggregate producers in a major metropolitan complex that is definitely expanding, we turn, now, from the simple bid-rent model to the Los Angeles urban area. Figure 4 shows the location of aggregate producers as of 1975, at which time seventy-one companies were active in the industry.

First, note that production sites are scattered within the various zones. No aggregate production sites are located within the innermost zone, that is, within ten miles of the Los Angeles CBD; and only two sites, Irwindale and Sun Valley, are located

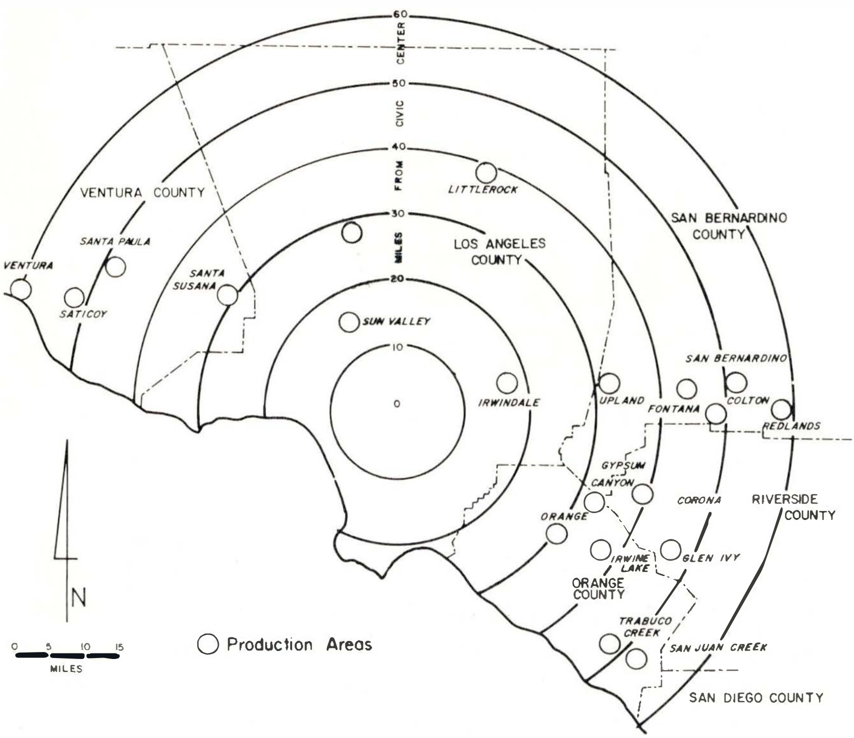


Figure 4. Aggregate Production Sites in the Los Angeles Urban Area

in the second zone, which extends ten to twenty miles from the CBD. Most of the aggregate production sites are located thirty miles or more from the CBD, mainly in Orange, Riverside, and San Bernardino counties, all of which are now undergoing rapid urbanization.

Considering the evolution of the Los Angeles metropolitan area, the location of aggregate producers fits well with our expectations. There are few surprises. Persistence of the close-in Sun Valley and Irwindale production sites is the only noticeable anomaly; few production sites can be found in Los Angeles County.

Furthermore, where aggregate sites occur they are characterized by clusters of pits and companies. For example, in the Temescal Wash production district eight different pits are operated by seven different companies (Figure 5). At this location only 169,160 tons of aggregate were produced in 1960, compared with a 1975 production figure of 1,980,173 tons, indicating production increases in such peripheral sites as production declines closer in. An example of the latter is the Tujunga fan production district, which reached a peak annual production of 6,772,488 tons in 1963 and by 1975 had dropped to an annual production of 4,324,988 tons. We stated earlier that as the urban area expands rising land values and competition for land use would force producers to relinquish close-in production sites and seek locations further away from the city center. An excellent example of this process occurs in Upland, where an aggregate production site is being reclaimed and converted to light manufacturing.

## Impact of Land-Use Controls Beyond the Urban Fringe

So far we have suggested that a bid-rent model, with expanding bid-rent curves in response to urban growth, could help us understand changes in the location of aggregate producers over time. What we end up with is a prediction of new sites continuously opening up on the urban fringe as sites are closed down nearer the CBD. At first glance it appears this process

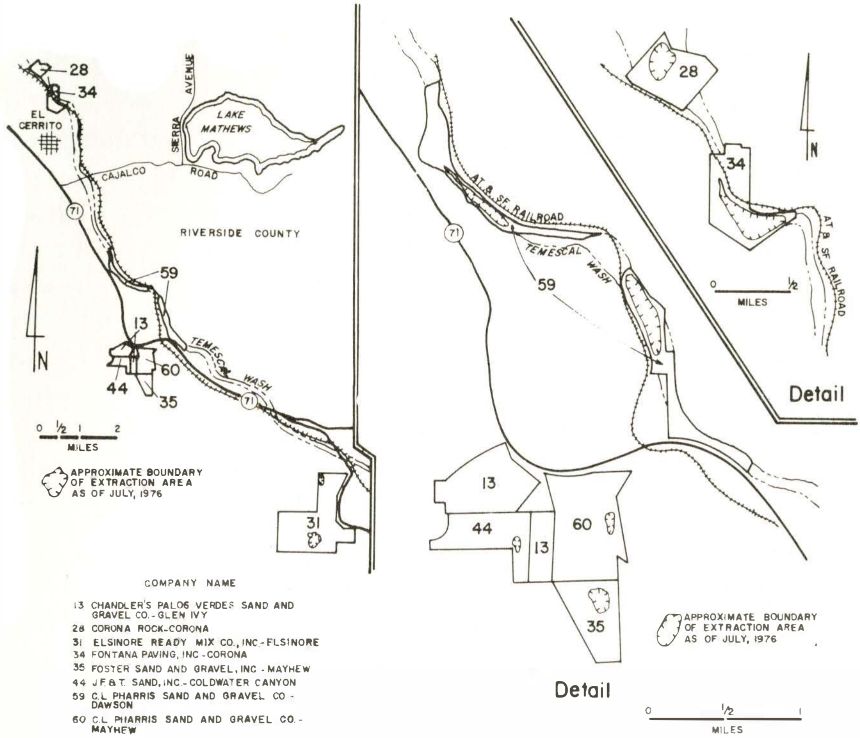


Figure 5.

could go on indefinitely. That, however, is deceptive, because it assumes not only that rural land uses continuously will give way in the face of competitive rents from urban land uses, but also that few, if any, controls exist to impede the opening of new aggregate production sites on the urban fringe. Neither of these assumptions is safe, because many rural areas are adopting measures to stem the impact of ever-expanding urbanization.

Recreational and agricultural land uses, for example, may be protected from conversion to urban areas. State and federal statutes may require either the establishment of agricultural preserves or the creation of strict, land-use plans for public lands, such as those for National Parks and for areas managed by the Bureau of Land Management. What occurs, then, is that aggregate producers find themselves caught, as the adage goes, "between a rock and a hard place."

Additionally, urban sprawl creates both a demand for aggregate and an increase in the bid-rent for current production sites. Hence, as building materials become scarcer and more expensive they will begin to impact housing costs, already driven up markedly since 1970. In turn the entire housing cycle and construction industry could be impacted. Even without further urban growth, replacement construction and in-filling would sustain a demand for aggregate at some reasonable level, whereas supplies may become inelastic and gradually even diminish.

Consider an example. We have indicated the expansion of aggregate production around the Los Angeles metropolitan fringe, and anyone familiar with this region might note the seemingly endless supply of rock, sand, and gravel that stretches across the desert and ask how aggregate supplies could ever run short. Indeed, some mining occurs there. Limestone, for example, is quarried for cement; and volcanic cinder is mined for use as a lightweight aggregate for concrete blocks, which are produced within the metropolitan region.

Conservationists and ecologists, however, are increasingly vocal about the need to protect fragile desert environments from the ravages of urbanism and industrialism. Current trends portend a marked change in the future use of California desert environments. The Bureau of Land Management has completed the California Desert Conservation Plan, which designates some desert lands for a variety of specific uses and also sets aside other tracts that are simply not to be used for any economic purpose. Elsewhere, too, rural areas are coming under governmental control, thus leading to some of the aggregate supply problems noted earlier.

## Resolving Conflicts Beyond the Urban Fringe

What we now have is an early warning about a seemingly innocuous industry and its attempt to provide essential building materials to expanding urban areas. In the not too distant future, metropolitan areas must consider options which can resolve conflicts between rural and urban land uses on and beyond the current urban fringe.

One option is to adopt a no-growth policy, though as we previously pointed out even no-growth does not end the demand for building materials within the urban complex. Another possibility is to count on obtaining variances in rural land-use controls. However, reliance upon this alternative is risky, depending ultimately on whether state or federal governments are more enticed by environmentalists and their plans for preserving natural environments or by advocates of urban sprawl, who contend that the city, with its people and jobs, is entitled to take what it needs from the natural environment. A third option, one that is far less risky, is to use urban zoning to set aside lands that are reserved for aggregate production. At the same time steps should be taken to sustain aggregate production on current sites for as long as possible. Existing legislation in California encourages local governments to provide for the continued use of aggregate production sites in the face of urban growth pressures. The California Surface Mining and Reclamation Act of 1975, for example, requires the state geologist to classify and delimit aggregate resources in thirty-three urban areas in California and to make this information available to local planners. The law requires that this information be utilized by local governments when developing their planning elements and zoning ordinances. A comprehensive approach to dealing with the need to provide for continued production of aggregate at the edge of metropolitan areas could represent the beginning of a governmental process that would establish a few long-term aggregate mining districts which could survive the increased land values and public pressures of expanding metropolitan areas. Such an approach would have the added benefit of reserving land for conversion to recreation or other uses at a future date, when aggregate production areas are eventually depleted. Solid waste disposal and recreation lakes are two of the most common secondary uses.

## NOTES

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