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AGGREGATE RESOURCES IN CENTRAL EASTERN NEW MEXICO

by

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FOREWORD

In the past, because of the relatively low unit value of sand and gravel and crushed stone, construction materials deposits were seldom surveyed in depth to determine reserves. However as the need for better quality aggregates in highway construction has grown, the New Mexico State Highway Department in cooperation with the Federal Highway Administration has embarked on an extensive research program to establish the reserves in New Mexico. This program has been completed for the southeastern part of the state and the study will be published in July, 1972. A complete set of geologic maps and an explanation of the aggregate resources and geology reported on a county to county basis will be presented in the publication. The following paper presents some of the highlights of this study on central eastern New Mexico and hopefully will draw attention to the importance of protecting the aggregate reserves in the state. The main subject of the paper is oriented toward road-building aggregates.

INTRODUCTION

The area covered by this paper reaches from the eastern flanks of the central mountain regions of New Mexico easterly to the Texas, New Mexico border and from Roswell northerly to the Canadian Escarpment and Central High Plains. The central mountain region is defined here as the northerly trending mountain ranges beginning with the Guadalupe Mountains below Carlsbad at the Texas, New Mexico border and extending through the Pedernal Hills near Clines Corner, New Mexico.

New Mexico is about twenty-first in total aggregate production among the United States. During the last 10 years total annual aggregate production throughout the state has varied from about 8 million to 14 million tons. About one-third of this was used commercially and two-thirds were used by government and contractor for building roads, dams, ditches, structures, etc. Less than 25 percent of the total amount of aggregates was produced in central eastern New Mexico.

PHYSIOGRAPHIC SETTING

Central eastern New Mexico lies in the Great Plains physiographic province of the United States. Some of the larger subdivisions within this area are: the Pecos Slope or Pecos section, the Mescalero Pediment, the Llano Estacado, and the Canadian River section. Various buttes, mesas, and lowlands representing further subdivisions are scattered about these features.

The Pecos Slope lies west of the Pecos River and it includes all the area between the central mountain region and the Pecos River. In central-eastern New Mexico it extends from Roswell northerly to the Glorieta Mesa. It is primarily a bedrock surface (erosional) with scattered relatively thin residual deposits of granular materials and local, rather flat topped constructional surfaces. The most prominent of these constructional surfaces are located at Yeso; at Ramon southeast of Vaughn; and west of Santa Rosa, northwest of the junction of U.S. 84 and I-40. Relatively thin sheets of caliche cover much of the bedrock surface.

The Mescalero Pediment lies east of the Pecos River and represents the area between the Pecos River and the Llano Estacado. It extends from Santa Rosa southeasterly to the Texas, New Mexico border. It is characterized by an evaporite on redbed surface with local shallow bolson deposits, windblown sand, and local caliche crusts.

The Llano Estacado in New Mexico extends from the Canadian River section or watershed on the north, southerly to the southeast corner of the state and from the Mescalero Pediment or Pecos River watershed on the west, easterly to the Texas, New Mexico border. In New Mexico the Llano is bordered on the north and west by a rather abrupt escarpment which is prominent at Ragland, Quay County, on the north. Regionally the Llano resembles a plateau with an easterly dipping, rather featureless surface. It is a huge constructional apron that formed during late Tertiary time and once extended from the central mountain region in New Mexico far into Texas. Pecos River dissection divided it from the central mountain peidmont during the Quaternary Period. Sand, gravel, silt, and clay of the Ogallala Formation are the primary materials of the Llano but these materials have a relatively thick soil cover and several cycles of soil genesis are apparent across this plain.

The Canadian River section lies in the northeast part of central-eastern New Mexico. It is limited on the south by the Llano Estacado and on the north by the central High Plains. It begins on the west at the drainage divide of the Pecos and Canadian watershed and extends easterly beyond the Texas-New Mexico border. This section is primarily an erosional surface cut on Jurassic and Triassic rocks with a thin soil cover and scattered caliche crusts. Near San Jon a relatively large deposit of aeolian sand covers this surface. Scattered buttes and mesas are common throughout the Canadian River section.

AGGREGATE RESOURCES

With qualifications, highway aggregate resources within this region are unlimited. The San Andres Limestone offers an almost limitless supply of quarry rock. Caliche capping the Llano Estacado and various other surfaces represents another generous supply of quarry stone. Excellent quality gravel chokes some of the tributaries that feed the Pecos River from the west; however, these deposits are rather limited in quantity and are restricted mostly to the southwest corner of this region. Well washed, excellent quality terrace gravel flanks the Canadian and Pecos Rivers in many places along their reach throughout this region. Pediment deposits furnish fair to good quality aggregate in local areas. Some relatively large areas are aggregate poor but there have been no serious haul problems when building bituminous roads. A problem arises when it is desirable to build concrete pavement for the Pecos and

Canadian river terraces are the main sources of supply for concrete quality aggregate, for most of this region. Even these sources have marginal quality materials in many places.

QUARRY ROCK

Limestone

Excellent quality limestone of the San Andres Formation crops out extensively in the southwest part of this region on the Pecos Slope and less frequently from about Vaughn northerly to the Canadian Escarpment. Coarse aggregate for all phases of highway construction can be produced from this formation. The quality of the rock normally remains good within the carbonate facies but it grades laterally and regionally into gypsum and occasionally into shale and limey, nodular mudstone.

The most extensive use of the San Andres Limestone for highways has been in the vicinity of Clines Corners on Interstate Highway 40. It is also an important source for U.S. Highway 84 south of Romeroville toward Dilia. In the vicinity of Vaughn and Roswell the presence of gravel and caliche usually obviates the need for limestone quarries, but in many areas over the Pecos Slope, gravel and caliche are rather scant and the use of limestone will probably increase in the future. It is expected that this formation will be the main source of supply for reconstructing U.S. Highway 285 between Clines Corners and Lamy Junction.

West of Vaughn in the vicinity of North Lucy, Pinos Wells, and Torrance the Yeso Formation may some day become an important supplier of limestone aggregate for roads. A relatively thin bed of argillic limestone crops out locally over this region and there is a paucity of other aggregate sources. The quality of limestone within the Yeso Formation is marginal but with a minimum amount of special handling it can be brought within specification limits for some roads.

Basalt

Railroad Mountain, northeast of Roswell, is a potential source of quarry rock. It is characterized by a long, narrow, crystalline, black diorite dike that rises rather inconspicuously above the Mescalero Pediment in an east-west direction. The dike rock itself is limited in exposure and has not been exploited for highway use. However it has been quarried for decorative stone and it is most suitable for road-building aggregate.

Rock Asphalt

A unique deposit of rock-asphalt occurs in the Santa Rosa Sandstone about 7¼ miles northeast of Santa Rosa. This rock was used quite extensively in the late thirties and early forties for bituminous roads because of its natural asphalt content. The asphalt is a residual product derived from oil in the underlying San Andres Limestone that has migrated up through sink holes and channels and accumulated in the sandstone. It is one of the few sandstone formations within the state that will pass Los Angeles Wear tests for roads. It has a L.A.W. value of 34.8 which is well within specification limits for all types of roadway aggregate. Most sandstone within the state has L.A.W. values in excess of 50 and is not suitable for highway construction.

Caliche

Over a great part of eastern New Mexico caliche has been the mainstay for road-building aggregates since the beginning of any road-building program. Farmers, ranchers, and early travelers on the High Plains recognized caliche as a very stable foundation material even before the days of the automobile. In the High Plains region one occasionally sees a house, barn, or stable constructed completely of caliche.

Geologists, engineers, farmers, ranchers, and soil scientists have coined many terms to describe caliche. Variations in the identity of caliche often cause confusion when the prospector is searching for a site that will produce durable aggregate. Caliche has been called croute calcaire, calcrete, duricrusts, hardpan, and caprock. Soil scientists refer to it as the petrocalcic zone in a soil profile and seldom use the term caliche. It is loosely defined as the "B" horizon of a soil profile enriched by the accumulation of calcium carbonate, but this description implies nothing concerning structure, texture, or the degree of induration which are of the utmost importance when selecting caliche for use as a roadway aggregate. Most geologists have ignored this material when mapping rock units, considering it to be merely a part of the soil forming processes and of no economic importance to the area of study.

The fact that strongly developed carbonate layers within New Mexico's soil profiles developed as a soil caliche is well established, but the form and character of many of these deposits are clearly a result of a complex series of desiccations, brecciations, alterations, recementations, and additions caused by extreme climatic changes during the Great Ice Age. Therefore it is believed that a "time stratigraphic" aspect may be applicable to some of the caliche profiles of New Mexico and they may deserve some attention as a rock unit. This is particularly true for the multiple caliche profiles which seem to be unique to the High Plains region.

Simple brief descriptive terms seem to be desirable when discussing caliche as a potential aggregate for roads; therefore, a brief glossary of some of the more useful terms is presented here.

Primary Terms:

Caprock caliche—the uppermost, well-indurated crust in a caliche profile, usually having one or more of the following structural characteristics: lamination (banding), brecciation (rock-house), pisolites (birdseye).

Nodular caliche—a zone of concretionary nodules, usually underlying the caprock, in a chalky or punky matrix; the texture of the matrix varies from friable, sandy to punky, clayey; the nodules vary from hard to soft, irregularly shaped to round, very small to large, closely to widely spaced, and often have a banded, birdseye structure.

Soft caliche—a carbonate-enriched soil that varies in texture from chalky, friable, loosely-cemented, to punky, clayey, cohesive.

Siliceous caliche—flinty, usually opalized caliche that has a high percentage of silica; possibly formed in or alternately exposed to ground water.

Caliche profile—a vertical section of any caliche sequence. A complete or normal caliche profile usually has a hard durable crust (caprock) followed by a lower nodular zone which grades downward into a soft caliche soil in which the nodules become more widely spaced or are absent.

This is a generalized, hypothetical composite; nevertheless, it follows the over-all lithology observed in countless profiles, although many of the exposures are not deep enough to show the entire sequence. Also, one or more of the horizons may be absent in any given profile.

Multiple profile—two or more caliche profiles, complete or incomplete, in a stacked position. Multiple profiles may be separated by paleosols (old soils) which have high percentages of clay.

Subordinate Terms:

Laminated caliche—well-indurated, hard, pure caliche with a banded structure; occurs in the caprock zone of the profile, often associated with brecciation and birdseye structure.

Birdseye caliche—pisolitic structure where banding occurs around a relatively small nucleus; the banding varies from light pink to dark red and sometimes black, reflecting the presence of iron and manganese; occurs in nodular caliche as well as the caprock.

Brecciated caliche—broken or weathered caliche which has been recemented.

Rock-house caliche—a combination of laminated, brecciated, and birdseye caliche that has been recemented and, when broken, gives the appearance of a rock-house; birdseye structure may be absent. Name is derived from typical rock structure of caliche near Rock House, New Mexico.

About three generations of caliche exist in central eastern New Mexico, and the quality of caliche as an aggregate is a reflection of its age. Normally the older caliche is the best quality. Certain conditions will cause this relationship to vary. The amount of carbonate available, the method of carbonate emplacement, sand cover or the lack of it, topographic position, type of bedrock, weather, and other factors can retard or accelerate caliche genesis. Generally the older-best relationship will hold and can be used to an advantage when locating durable materials.

Caliche development in central eastern New Mexico is associated with the following geomorphic surfaces, oldest to youngest: 1) Llano Estacado and residual pediment deposits on the Pecos Slope; 2) Aiken Ranch surface [Buchanan Mesa surface of V. C. Kelley, this Guidebook], and its associated outliers including Conejos Mesa, the aggraded surface southeast of Vaughn, the aggraded surface west of Santa Rosa, and the mesa south of Cuervo; and 3) Mescalero Pediment and the associated caliche crusts on the lower erosional surfaces including the Canadian River section and the Rio Portales section. The age of caliche development is listed here as older or younger because of its geomorphic relationship; absolute age in point of time is undetermined.

Exposures along the western escarpment of the Llano Estacado indicate that some form of caliche exists below a large part of this surface. Exploration has proven that it is not universally underlain by caliche, at least not within the top 25 to 50 feet. Exposures along the escarpment and within some of the pit sites show that multiple profiles are also common. The stages of development of the upper crusts or exposed crusts of caliche across the Llano will vary from very youthful to late in maturity. Some of the older profiles have undergone attacks from solution and weathering and can be expected to be extremely discontinuous. Although this surface has remained quite stable for hundreds of thousands of years, aggradation and degradation have continued at a slow, steady pace. The result, considering the climatic fluctuations of the past one million years, has been degradation and recementation of the profiles on the windward and uphill side of the plain and aggradation on the lee side of the plain, the rock-house type structure being more common in older profiles, and lamination more common in younger profiles.

Highly indurated caliche deposits occur extensively along the western edge of the Llano and randomly throughout its interior. Although some form of caliche or carbonate has developed near the surface of the plain's interior, degradation and aggradation have caused many lateral and regional changes within the upper crust. Local crusts may be equivalent in age to those of the lower, younger surfaces.

In any event the best quality caliche within this region is associated with the Llano Estacado surface. The typical Llano caliche has a well-indurated, laminated often brecciated caprock that varies from 3 to about 6 feet in thickness. Usually the top is laminated and the lower part is both laminated and brecciated. Pisolitic (birdseye) structure is common throughout the caprock zone. Below the caprock the material will vary locally as well as regionally. Typically there is a zone of concretionary nodules in a soft, chalky, often cohesive caliche matrix. The caprock is preferred for aggregate, but the nodular zone may be used provided that the nodules are sufficiently hardened. In many profiles a rather blocky, punky caliche occurs immediately below the caprock zone. This material is often mistaken for hard caliche because of its characteristics when it is dry. It is highly cohesive yet breaks apart in subangular blocks and pieces when struck with a hammer. In many cases the quality of this material can only be determined by laboratory analysis.

Good to excellent quality aggregate for untreated surfacing materials as well as asphalt products has been produced for most of the caliche horizons of the Llano. Quality tests are usually well within specification limits for major road-building projects. More asphalt is required in caliche aggregates than clean river gravels and limestone aggregates because caliche has higher absorptive qualities.

Although the quality of the Llano caliche is generally good it varies from place to place. Some of the younger deposits, those that form the upper crust of recently aggraded areas and those on the windward side of the small playas, will fail some of the quality tests for major highway construction, but the county maintenance crews have made excellent all-weather surface roads by utilizing the softer materials. They seem to be preferred by the county road departments because of economical construction costs.

Caliche deposits capping some of the gravelly residuals or high gravelly surfaces that flank the central mountains within this region are probably comparable in age to the older deposits of the Llano Estacado since it is believed that these deposits were once continuous with the High Plains. However, they have been subjected to severe erosion and no multiple profiles have been observed. These deposits are rather scant but they will be of great value locally when building roads.

Caliche deposits on Aiken Ranch surface will furnish fair to good quality aggregates. Aiken Ranch is located near Yeso, New Mexico. This particular surface has no geographic name and has been labeled Aiken Ranch here in order to explain its genetic relationship to the other surfaces in central eastern New Mexico. Because of its topographic position and the degree of induration of its caliche profile it is believed to be post-Llano but pre-Mescalero in age. The caprock averages about 2 feet in thickness but the degree of induration varies. The harder materials are usually found on the points of higher elevation. Frequently the nodular zone below the caprock is sufficiently indurated for aggregate use. This caliche generally is comparable to that of the Llano Estacado in quality; however, the profile is not so mature, the laminar zone is thinner, and multiple profiles are absent. In some areas braided channels of relatively fine-grained gravels lie below the caliche caprock. The caliche rock here will furnish most of the aggregate for reconstructing U.S. Highway 60 between Vaughn and Fort Sumner.

As previously mentioned other surfaces similar to or geomorphically related to Aiken Ranch are scattered about central eastern New Mexico. Like the Aiken Ranch surface most of these surfaces have no geographic name. Also like the Aiken Ranch surface caliche and gravel are associated in local areas. Immediately southeast of Vaughn a relatively extensive constructional surface has good quality caliche. This caliche is somewhat thicker but similar in quality to the Aiken Ranch material. The braided channel gravels are more coarse grained and thicker below this surface than they are below Aiken Ranch proper. Relatively thick deposits of caliche overlie limestone bedrock immediately west of this area.

Several hundred thousand tons of caliche have been mined from an area about 6 to 10 miles west of Santa Rosa along Interstate Highway 40 for use as base coarse aggregate on I-40. Here the surface seems to be more erosional as the caliche deposits are in contact with the Santa Rosa Sandstone.

East of Santa Rosa, immediately south of Cuervo, another erosional surface has generous supplies of caliche. Here the caliche is almost immediately in contact with the Chinle Formation. Many hundred thousand tons have been removed from this surface to construct I-40.

Poor to fair quality caliche occurs on the Mescalero Pediment and other genetically related surfaces. A relatively large outcrop of good quality caliche occurs on this surface in T. 2 N., R. 28 E. Otherwise caliche on this surface is of poor quality. It is relatively soft, nodular, and grades laterally into clay and sandy soils. As in other parts of eastern New Mexico it can be used for all-weather roads to a remarkable advantage. It is easily worked as pit-run material, and after watering and rolling it becomes a very stable surface.

The surface of the Canadian River section has caliche deposits similar to those of the Mescalero Pediment. The reserves for primary road construction in both areas are very small and usually not considered except as a last resort.

In contrast to the Mescalero Pediment and Canadian River section the Rio Portales section has deposits of good quality caliche. One explanation for this phenomenon may be that the Mescalero and Canadian caliche profiles have been exposed to more vigorous erosion. The Rio Portales section reaches from Taiban, New Mexico, southeasterly to the Texas, New Mexico border. The caliche is rather limited in outcrop but a few good materials pits have been located in the vicinity of Portales and west of Portales. No usable deposits of caliche have been found in th main valley floor of the Rio Portales; most of the more durable materials lie along the southern flanks.

SAND AND GRAVEL

Well-washed deposits of good quality sand and gravel are restricted to the terrace deposits that flank the Canadian and Pecos rivers. A small amount of gravel is available within the Pecos River channel itself north of Fort Sumner. Even these deposits are not consistently good throughout their reach in New Mexico. Locally distributed gravel occurs on some of the old erosional surfaces, and, with few exceptions, is generally of poor quality, usually fine grained and often contaminated with clay. Gravel along the eroded slopes of Aiken Ranch surface, that along the low hills in the southwest evaporite valleys, that along the eroded slopes of the Llano Estacado, and the deposits within the intermittent streams are typical examples of locally distributed gravel. Locally distributed gravel, intermediate in quality, lies immediately southwest of Vaughn below the caliche capped constructional surface, about 2 miles north of Interstate Highway 40 ten miles west of the I-40/U.S. 84 interchange, and near the county line west of Roswell by U.S. 70 and 380.

Terrace and Channel Deposits

DeBaca County has the greatest quantity of well-washed terrace gravel along the Pecos River drainage system in central eastern New Mexico. From DeBaca County northerly through Guadalupe County the terrace deposits dwindly considerably in size and in many places are contaminated with clay.

The rock terraces lying north of U.S. Highway 60 along the Pecos River are capped with gravel deposits that range in thickness from 3 to about 50 feet. These deposits are very coarse-grained, well washed, well sorted, and generally quartzitic, but they have a small percentage of sandstone clasts and some silt and clay interbeds. In the northern part of DeBaca County the higher terrace gravels are capped by caliche.

South of the Fort Sumner bridge where the middle and lower rock terraces merge with the alluvial terraces west of the Pecos River, the gravel deposits remain good, but they are somewhat more fine grained than those to the north.

Yeso Arroyo, a major tributary of the Pecos River, has a series of gravel capped terraces similar to those of the Pecos and the quality remains good, particularly where they merge with the Pecos Terraces.

To the east of Pecos River and south of U.S. Highway 60, where the Pecos has carved a rather subtle terrace during its recent transgression into its present channel, the gravel deposits are not so obvious as they are within the higher terraces. These deposits lie below the Sutter terrace. Here the more granular materials seem to lie in braided channels below the surface, and their surface expression has been greatly modified by land-leveling for agricultural purposes. These deposits are medium to coarse grained, quartzitic with some sandstone pebbles, and have a relatively high percentage of clay balls. The average thickness is about 25 feet, and they have a high ground-water table. The Fort Sumner Irrigation Project is restricted almost entirely to the Sutter terrace, and most of this terrace has been developed for farm use. Therefore, it is constantly subjected to irrigation, and the ground-water reservoirs (i.e., the braided channel gravels) are quickly recharged from this source.

The Pecos Channel proper, north of U.S. 60 bridge at Fort Sumner, also has excellent quality materials. Here again water becomes a problem, either from the stream itself or from a high ground-water table when stream flow has been cut off at the Alamogordo Reservoir. These deposits are rather limited in size, and the presence of dry sources usually precludes their use.

Good quality terrace gravel is rather scant along the Pecos River from the vicinity of Dilia where the Pecos leaves the Canadian Escarpment to the DeBaca-Guadalupe County line. In the vicinity of Santa Rosa the deposits are heavily contaminated with clay and clay balls. There seems to be no economical means of separating this clay from the gravel and it is more practical to resort to other sources for highway materials in this vicinity.

The Canadian River terrace deposits are similar in quality to those of the Pecos River. The quantity as well as the quality improves tremendously after the river leaves Conchas Reservoir. Immediately below Conchas Dam the river has been in contact with many redbed and shale formations of Jurassic and Triassic age. Farther east, from about the vicinity of where the old Southern Pacific Railroad crosses the river the quality of the materials improves tremendously and concrete quality aggregates have been produced without the use of water.

Surficial deposits of good sand and gravel are scarce in Curry and Roosevelt Counties. The better quality materials have been depleted in the Tolar area. Pit-run concrete sand was produced for many years from Arroyo Canadienes and Taiban Draw for small concrete jobs. At their best, deposits near Tolar would only make fair quality fine aggregate.

The sand and gravel deposits in the old Rio Portales channel north of Portales have been well exploited and continue to furnish several thousand tons of fine-grained aggregate for commercial purposes each year with no apparent evidence that they will be depleted within the immediate future. Many thousands of tons of road-building aggregates have also been produced from this source, usually to be used in combination with other more coarse-grained materials of the area.

Channel deposits of the Rio Portales are rather unique in that they are the only known source of recently deposited gravel within the Llano Estacado region. The better gravel seems to lie near the center of the wide scour, and it is as much as 80 feet thick. Undoubtedly the gravel feathers out to the northwest as the old channel approaches the Pecos watershed and perhaps may thicken in the aggraded channel to the east. Evidence of these channel gravels has been discovered several miles east and west of the main diggings, at surprisingly shallow depths. Even though these materials are rather fine grained, they remain the largest near-surface gravel reserve for the region.

Excellent quality aggregates for various types of construction have been produced from the sand and gravel sources mentioned above. With a minimum amount of special handling aggregates can be produced for all types of highway construction. A problem may arise when producing concrete aggregate from the Sutter terrace because of the high ground-water table. However, the high ground-water source has been used to an advantage in concrete aggregate production where washing is required.

At the present rate of consumption along the Canadian and Pecos River terraces the reserves are practically unlimited. However a marked increase in the demand for concrete aggregates throughout eastern New Mexico and West Texas could rapidly deplete these deposits because they represent the most readily available resources for this part of the country.

Pediment Deposits

Fair to good quality aggregates can be produced from the pediment gravels that lie below Aiken Ranch and its associated surfaces. Gravel below the surface southwest of Vaughn is considerably more coarse grained than it is under the Aiken Ranch surface proper. In both areas the deposits are poorly exposed. They can be observed only along recently dissected areas and along the escarpment that defines the limits of the surfaces.

Comparable deposits occur on the aggraded surface southwest of Vaughn and west of Santa Rosa.

The best quality aggregates can be produced from the area southeast of Vaughn and the area west of Santa Rosa. These materials are medium to coarse grained, quartzose and granitic, and often caliche coated in their upper portions; locally, decomposed granitic clast may lower the quality in the Vaughn area. Waste is usually required when producing highway aggregates. On the Aiken Ranch surface and west of Santa Rosa a resistant caliche caprock quickly dominates the surface plateauward from the outcrop. Caliche is often used in conjunction with gravel in base coarse aggregate and bituminous surface course aggregates. The asphalt content is somewhat difficult to control when caliche and gravel are used for bituminous surfaces for each has different absorptive qualities.

The deposits west of Santa Rosa, although they are rather local in outcrop, have been used quite extensively in constructing Interstate 40 and the reserves have been seriously depleted. It is expected that the deposits southeast of Vaughn will be used extensively in reconstructing U.S. 285 toward Roswell.

The basal part of the Ogallala Formation contains coarse -grained gravel in the old channels of the late Miocene erosional surface. The gravel is exposed locally along the escarpment of the Llano Estacado, but commonly is buried far below the Llano surface because the soil and caliche cover thicken rapidly eastward from the escarpment. The gravel generally is of poor quality, highly decomposed, and conglomeritic but occasionally usable deposits are exposed. Commonly the presence of good quality caliche precludes the need to use these materials but they are considered when economically feasible.

SUMMARY

As a generality, it may be stated that resources of sand and gravel and crushed stone are sufficient to meet the demands created by any forseeable expansion in the economy of central eastern New Mexico. This does not mean that good-quality materials are universally distributed in every area nor that all marginal deposits can be processed to supply satisfactory aggregate. Good concrete-quality aggregates, i.e., river washed sand and gravel, could become scarce in the future.

Rapid and undirected land development programs could eliminate many potential reserves, not only by restrictive zoning ordinances, but by overspreading deposits with roads, houses, apartments, and business districts. Reserves of better quality materials in other parts of the state and other parts of the United States have been menaced by the rapid expansion of rural zoning restrictions and there is no reason to believe that it could not happen to central eastern New Mexico. If this problem arises some consideration should be given to allow extraction of the construction materials before the deposits are lost forever for land restoration is a fairly simple process particularly along river terraces.

REFERENCE

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