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THE DESERT SOIL-GEOMORPHOLOGY PROJECT

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The Desert Soil-Geomorphology Project refers to a Soil Conservation Service, USDA, investigation between 1957 and 1972, of landscape evolution and soil development in a 400 sq mi area of Dona Ana County, New Mexico (Fig. 1). Its primary purpose was to gather basic information on soil-geomorphic relationships that would lead to increased accuracy and efficiency of the Soil Survey program in arid and semi-arid regions of the western states. A team of soil scientists and geologists from the S.C.S. Soil Survey Investigations Division under the direction of Guy D. Smith staffed the project. Research geologist R. V. Ruhe conducted initial geologic-geomorphic field studies from 1957 to 1960 and headed the project from 1957 to 1965. F. F. Peterson and J. W. Hawley were responsible for geomorphic and geologic research from 1960 to 1962 and 1962 to 1972, respectively. L. H. Gile was in charge of soils investigations for the duration of the project. Field research involved close collaboration with the Soil Survey Laboratory staff, particularly the Lincoln, Nebraska unit headed by R. B. Grossman. Work was done cooperatively with the New Mexico State University College of Agriculture, and Departments of Biology and Earth Sciences, and the New Mexico Bureau of Mines and Mineral Resources. The NMSU Agricultural Experiment Station and Department of Agronomy provided office and laboratory space, and numerous other supporting services for the 15-year period.

The project area is typical of large parts of west-central North America, and results of investigations can be applied in many other warm-arid regions, particularly those with basin and range topography. The area comprises the northern Mesilla Valley segment of the Rio Grande, parts of two internally-drained intermontane basins, and several mountain masses. Because of striking differences in rock units exposed in source watersheds in local mountains and the upper Rio Grande basin (e.g. rhyolite, monzonite, limestone, and mixed fluvial deposits), it has been possible to study effects of various bed-rock and alluvial parent materials on desert soil development.

Field investigations in the project area included mapping of geomorphic surfaces, geologic units, and soils at scales ranging from 1:8,000 to 1:24,000. Detailed studies were also made in the Rincon Valley area of northern Dona Ana County, and reconnaissance investigations were conducted at a number of sites elsewhere in the Basin and Range province. Geologic studies emphasized late Cenozoic stratigraphy, geomorphic surface mapping, and sedimentology and hydrogeology of basin and valley fills. Pedologic investigations were concerned with the morphology, genesis, and classification of desert soils, and soil-geomorphic relationships.

Work during early phases of the project demonstrated that a great variety of geomorphic surfaces and soils occur in the study area and that these units range widely in age, encompassing most of the Quaternary Period. Buried soils were found to be common and useful markers in assessing the pedologic and geomorphic history. There is good correlation of degree of soil development with age of geomorphic surface. Soils of youngest geomorphic surfaces are weakly developed and have relatively simple morphologies, while soils of older surfaces have morphologies that progressively increase in complexity and strength of development with age. The calcic, petrocalcic, cambic, and argillic horizons—major diagnostic horizons of the new U.S. system of soil classification—were also studied in detail. Dust traps were installed at sites in the project area to measure dust-fall contributions to soil parent materials. Slow atmospheric additions (including mineral constituents in precipitation) to surficial materials in relatively stable landscape settings were found to be a significant factor affecting soil development.

Studies of soil genesis were greatly assisted by time-stratigraphic control on the age of many pedogenic features. Information on soil age has been obtained from carbon-14 dating

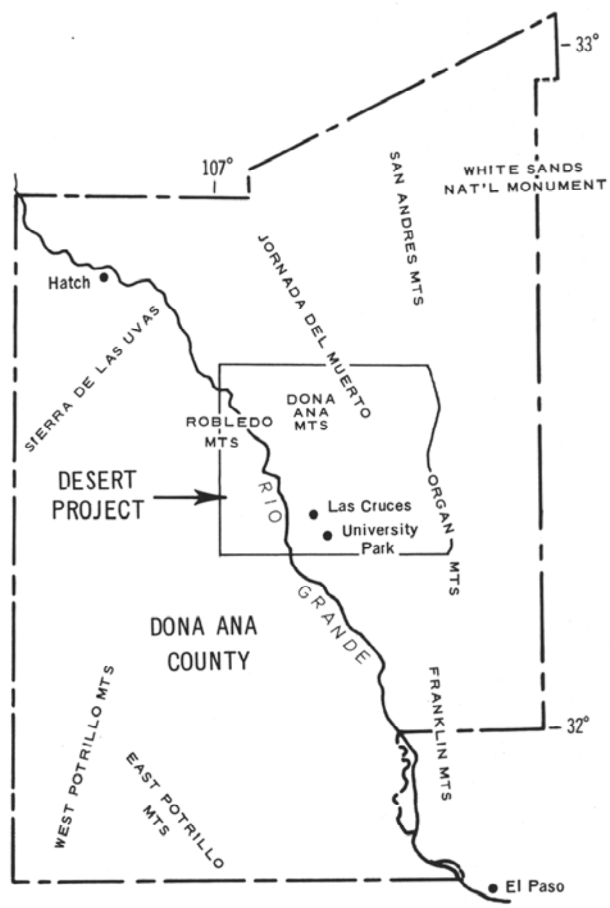

Figure 1. Location of the Desert Soil-Geomorphology Project in Dona Ana County, southern New Mexico.

1. On Intergovernmental Personnel Act assignment with the New Mexico Bureau of Mines and Mineral Resources.

of charcoal in sediments that either form soil parent materials or bury pre-existing soils; and C^{14} activities of secondary organic and inorganic carbon in soil horizons have been determined. Soils have also been dated by paleontologic methods, volcanic ash correlation, and physical tracing of stratigraphic units, geomorphic surfaces and soils during detailed mapping. C^{14} dating of inorganic and organic carbon in horizons of soil-carbonate accumulation involved closely controlled sampling of representative morphological forms whose relative age, in terms of sequence of development, had already been determined. This has been useful in relating the C^{14} activities measured to an absolute chronology of horizon development, and in explaining seemingly anomalous carbonate horizon dates.

Reconstructing past biologic and hydrologic environments posed a complex problem. More or less standard geologic and pedologic approaches needed to be supplemented with research in paleoecology and paleohydrology. Comparative studies of modern and fossil floras and faunas by cooperating biologists and paleontologists proved valuable in establishing working models of past climate changes. These climatic models were helpful in relating present and past climatic regimes to observed soil morphological features and patterns of erosion and deposition. In soils of Pleistocene age, for example, certain horizon morphologies formed under climates significantly more moist than the present. The Quaternary stratigraphic record in both river valley and intermontane basin settings indicate that relatively short episodes of landscape instability, characterized by erosion, or combined erosion-sedimentation, alternated with longer intervals of widespread surface stability and soil development. The major erosion and deposition episodes appear to have coincided with world-wide shifts from full glacial to interglacial climatic regimes that resulted in increased aridity and decreased effectiveness of vegetative cover in the Desert Project region. Paleohydrologic reconstructions showing water-table positions at various stages of valley entrenchment were useful in assessing water-table effects on pedogenesis. For example, in most cases it can be shown that horizons of carbonate accumulation in soils of the region formed within several meters of stable land surfaces, and 10 to 100 m above the water table, by precipitation of carbonate from downward moving soil-water solutions.

Results of Desert Project research have been disseminated in two ways-by publication and by numerous 1- to 4-day training tours of the project area. The tours utilize a guidebook prepared to illustrate detailed soil-geomorphic relationships at about 25 representative sites in the area. Size of visiting groups has ranged upwards to about 100 persons. More than 30 journal articles and technical reports covering most aspects of project research have been published during the course of the investigation. The following list of publications and graduate theses includes reports by both the Soil Survey staff and personnel of cooperating institutions. A final edition of the Desert Project Guidebook, and monographs on geology and soils are currently being prepared by Gile, Hawley, and Grossman.

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