GEOHYDROLOGY OF THE HIGH PLAINS AQUIFER SYSTEM, CHEYENNE URBAN AREA, WYOMING

By M.E. Cooley and M.A. Crist

INTRODUCTION

Cheyenne, Wyoming, with a population of about 50,000, is located primarily in the valleys and lowlands of Crow Creek and its main tributaries Dry Creek, Clear Creek, and Allison Wash (fig. 1). Ground water at shallow depths has hampered construction in parts of Cheyenne. During wet years, shallow ground-water problems such as seepage into basements and along footings for buildings have resulted in many queries and complaints to city officials (Gary Grunkemeyer, Cheyenne City Engineer, oral commun., 1987).

The potential adverse effects of shallow ground water on urban development in the vicinity of Cheyenne created a need to acquire detailed information about the ground-water system that is of a different type and focus than provided by previous ground-water studies. Previous ground-water studies described the withdrawal and use of ground water. As a result, the U.S. Geological Survey, in cooperation with the City of Cheyenne, conducted a study to qualitatively describe geohydrologic conditions of the shallow ground water system.

This report presents the results of that study. Specifically, the report describes the geohydrology of the High Plains aquifer system and some effects of urban development on the aquifer system in the Cheyenne area in order to provide base-line information for additional investigations concerning the shallow ground water and its effects on urban development.

The study was conducted during 1985-87 and consisted of detailed mapping and description of the surficial deposits and artificial fill to determine their relationship to the aquifer system. Hydrologic information was collected to determine the general extent of the aquifer system, water-level conditions, potentiometric surfaces, perched-water zones, the recharge and discharge relations as well as movement of the water, and limited water-quality conditions. Finally, the information was used to determine the general effects of urban development on the aquifer system and the perched-water zones. In this report, only the upper part of the aquifer system is emphasized.

Previous Investigations

The earliest investigation of the ground-water resources of the Cheyenne area was by Darton and others (1910). Ground-water conditions in Crow Creek valley (Knight and Morgan, 1937) and in the Cheyenne area (Theis, 1941) were studied during the 1930's and 1940's. Comprehensive reports prepared by Foley (1943) and Morgan (1946) include descriptions of the principal water-yielding units and the location of wells equipped with pumps, flowing wells, and springs. Reports containing considerable detail about ground-water conditions, including potentiometric-surface maps of selected parts of the High Plains aquifer, were prepared by Babcock and Bjorklund (1956), Lowry and Crist (1967), Crist and Borchert (1972), Crist (1980, 1985), and Avery and Pettijohn (1984). A stratigraphic fence diagram (Cooley and Crist, 1981) shows three-dimensional relations of the potentiometric surface to the water-yielding units of the High Plains aquifer. Information about soils of the area was presented by Karlstrom and Reider (Wayne and others, 1991, p. 455). A brief history of Cheyenne's water system was made by Carroccia (Tribune Eagle, Cheyenne, Wyo., July 5, 1992, p. 4).

Methods of Investigation

The geology, particularly of the surficial deposits, was mapped in detail to determine the distribution of the sedimentary units in the upper part of the High Plains aquifer (Cooley, 1987). Aerial photographs taken in 1984, enlarged to a scale of 1:2,400, were used as base maps for the geologic mapping. These photographs, having topographic contours (2-ft intervals) superimposed on them, also are used by the City of Cheyenne for land-use planning. Other aerial photographs taken in 1941 and 1947 show the progressive growth of Cheyenne and also aides the geologic mapping.

Many of the lithologic descriptions and thicknesses of the sedimentary units were obtained from 45 test holes augered to maximum depths of 35 ft by U.S. Geological Survey personnel, from drilling information in the files of the Wyoming State Engineer and the Wyoming State Highway Department, and from test-hole data listed in reports prepared by Empire Laboratories, Inc. (1983a-c; 1984a,b). The depth to water in the test holes was measured where possible. Substantial lithologic and depth-to-water information also was obtained by observing conditions in excavations for basements, foundations, and trenches dug for water, sewer, and gas lines.

The depth to water was measured in many wells, and used to identify different water-bearing zones including possible relations between the shallow and deep zones. Information was obtained from residents living in the area and from onsite observations of seepage, including the direction of seepage, of perched water into excavations, basements, and other structures, and the location of artesian wells that in 1987 were flowing or were reported to have flowed during the past. Stream-discharge and specific-conductance measurements were made at various sites along Crow and Dry Creeks to determine locations of ground-water discharge to the streams and to gain information on the general chemical quality of the streamflow. Specific-conductance measurements also were made for many of the ground-water samples collected from area wells.

Well-, Spring-, and Pond-Numbering System

Wells, springs, and ponds in this report are numbered according to the Federal system of land subdivision in Wyoming (fig. 2). The first number indicates the township, the second number the range, and the third number the section in which the well is located. Letters following the section number indicate the position of the well within the section. The first letter denotes the quarter section, the second letter the quarter-quarter section, and the third letter the quarter-quarter-quarter section (10-acre tract). The subdivisions of a section are lettered a, b, c, and d in a counterclockwise direction, starting in the northeast quadrant. A sequence number, beginning with 01, is assigned to distinguish wells within the same 10-acre tract.

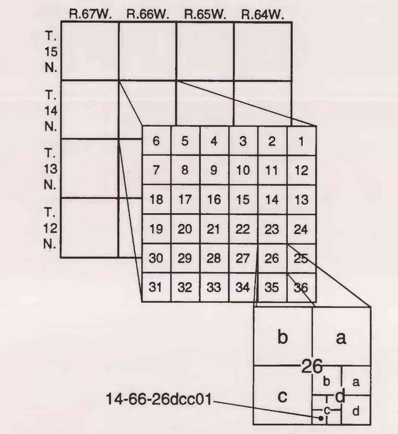

FIGURE 2.--Well-, spring-, and pond-numbering system.

Acknowledgments

The authors gratefully acknowledge the substantial geologic and hydrologic information about the Cheyenne area provided by government agencies, companies, and residents. The Cheyenne City Engineer provided much useful information about seepage areas and test holes drilled for other studies. Personnel of the Wyoming Highway Department provided considerable subsurface information concerning test drilling along highway right-of-ways. Many water-level measurements and depths of wells were obtained from files maintained by the Wyoming State Engineer. Personnel of the Frontier refinery provided water-level measurements in many shallow wells. Mr. and Mrs. R.R. Jones, long-time residents of Cheyenne, supplied information about the location of numerous flowing wells and springs and described some past environmental conditions. Personnel of the Cheyenne Municipal Airport provided information about seepage and drainage at the airport. Information concerning geomorphology of the surficial deposits was contributed by E.T. Karlstrom, University of Kansas, and Brainerd Mears, Jr., and R.G. Reider, University of Wyoming.

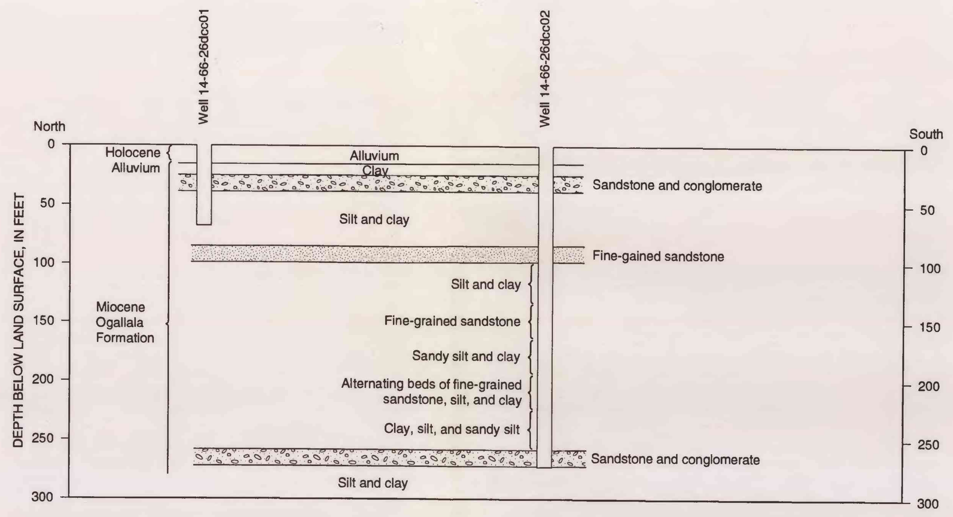

FIGURE 6.--Diagram showing stratigraphy in nearby shallow and deep wells completed in the Ogallala Formation. Wells are 30 feet apart.

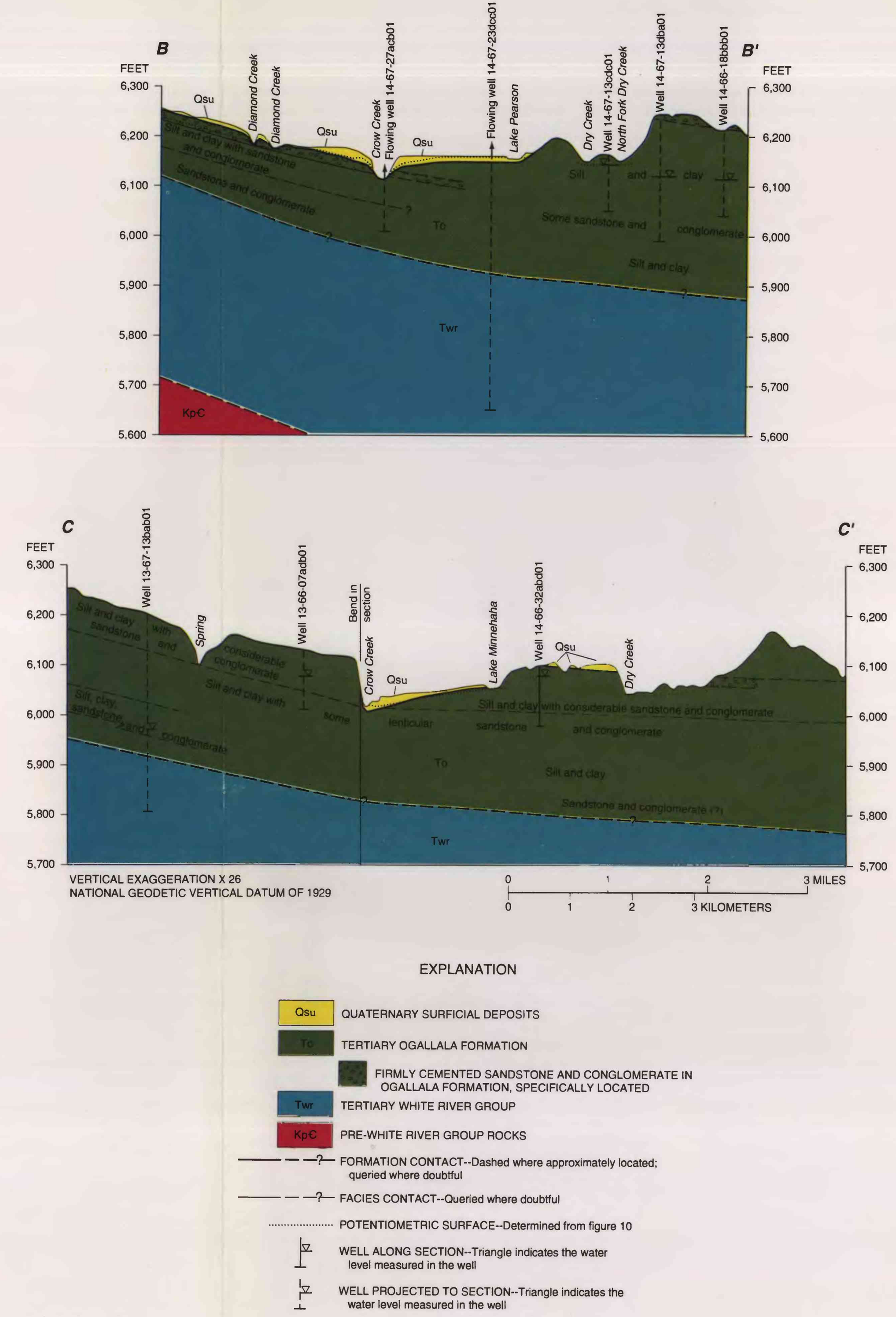

FIGURE 8.--Geohydrologic sections showing general lithology of the Ogallala Formation and potentiometric surface of the upper part of the High Plains aquifer system. Traces of sections are shown in figure 7.

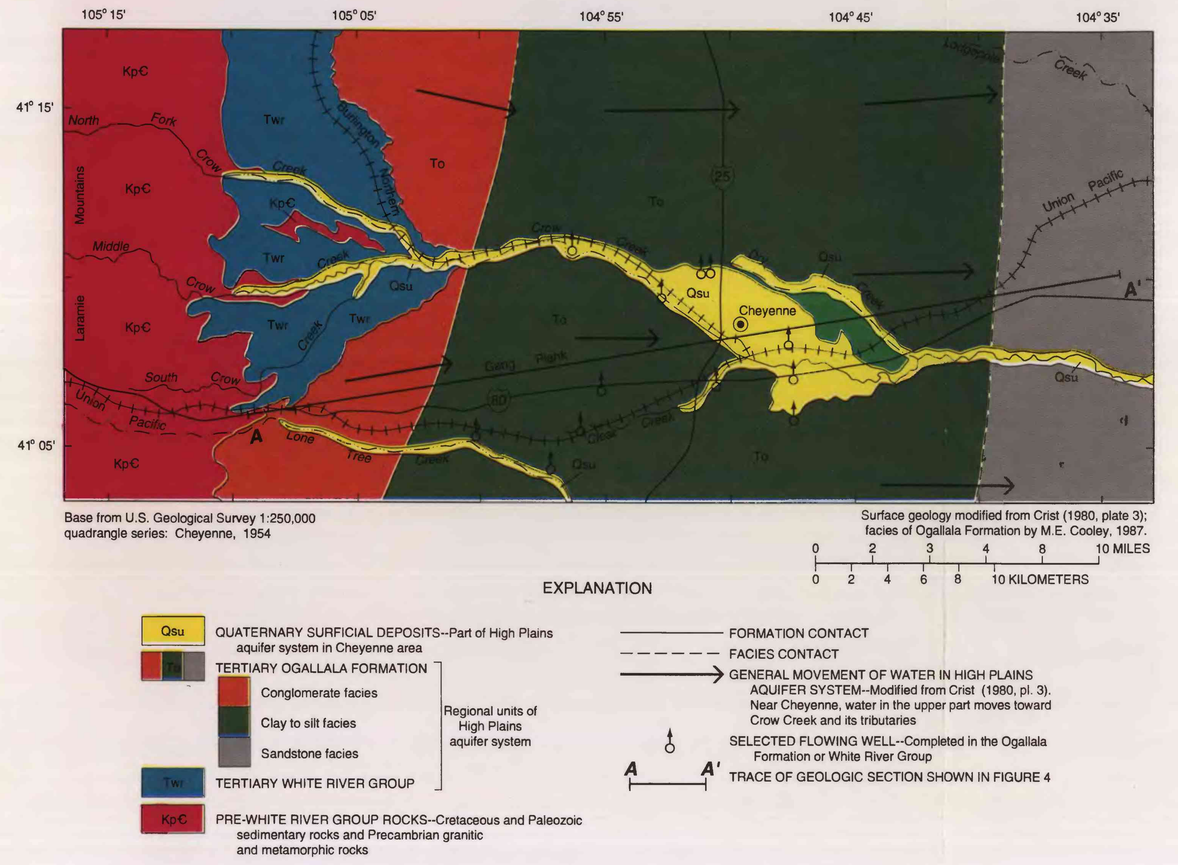

FIGURE 3.--Generalized geologic map showing units of the High Plains aquifer system.

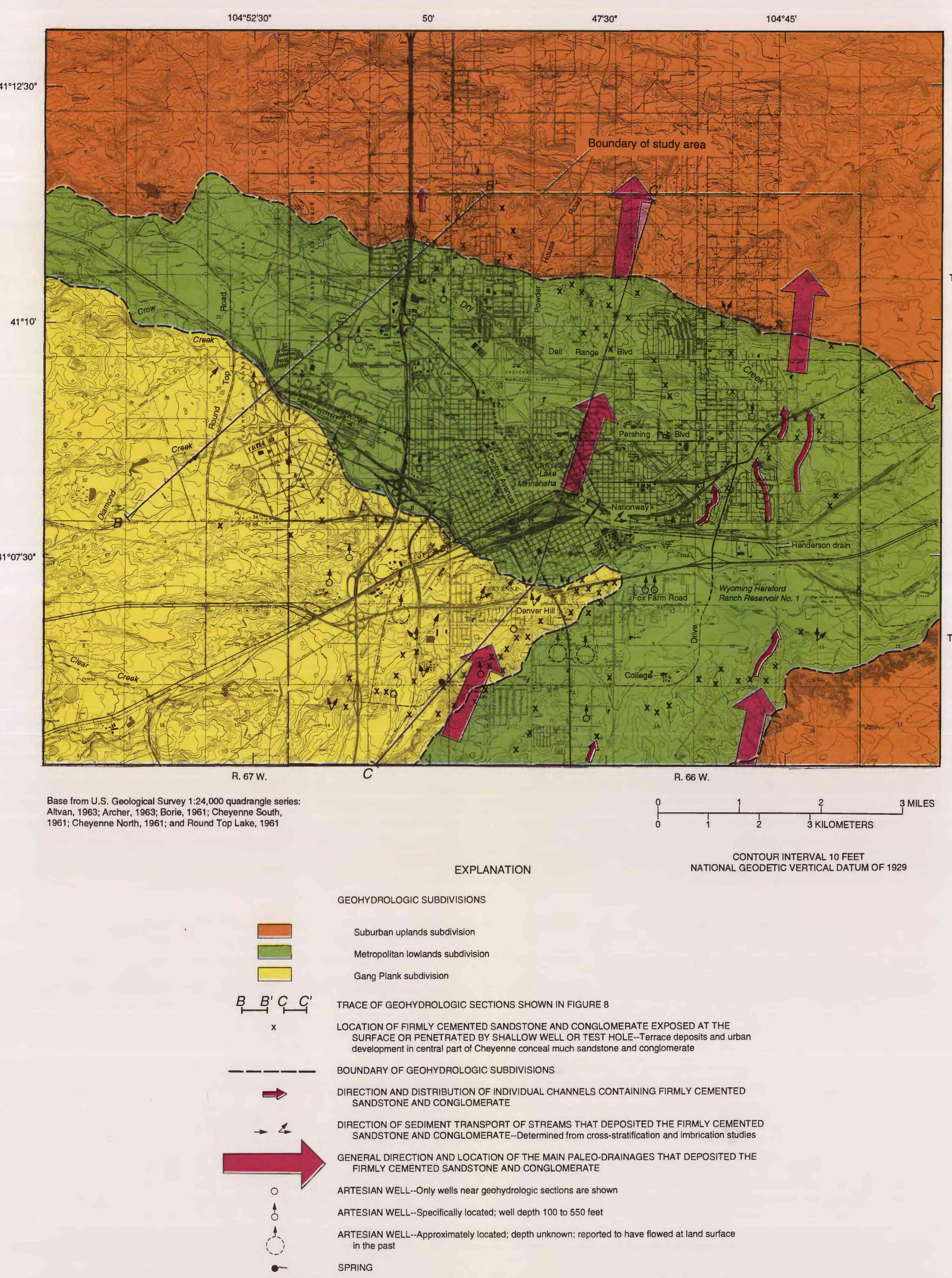

FIGURE 7.--Geohydrologic subdivisions, distribution and direction of sediment transport for the sandstone and conglomerate units in the Ogallala Formation, location of the flowing wells and springs, and general direction of the main paleo-drainages in the upper part of the High Plains aquifer system.

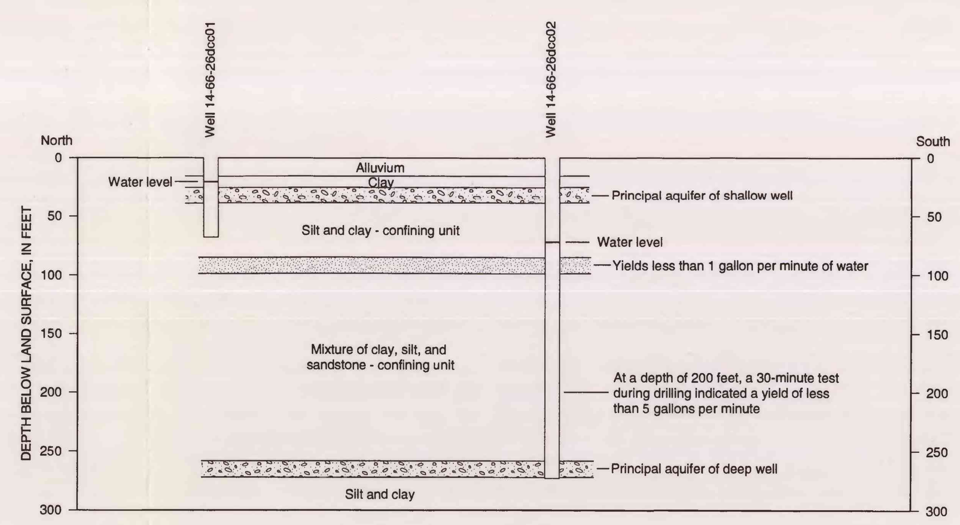

FIGURE 9.--Diagram showing hydrologic conditions in nearby wells completed in the Ogallala Formation. Wells are 30 feet apart.

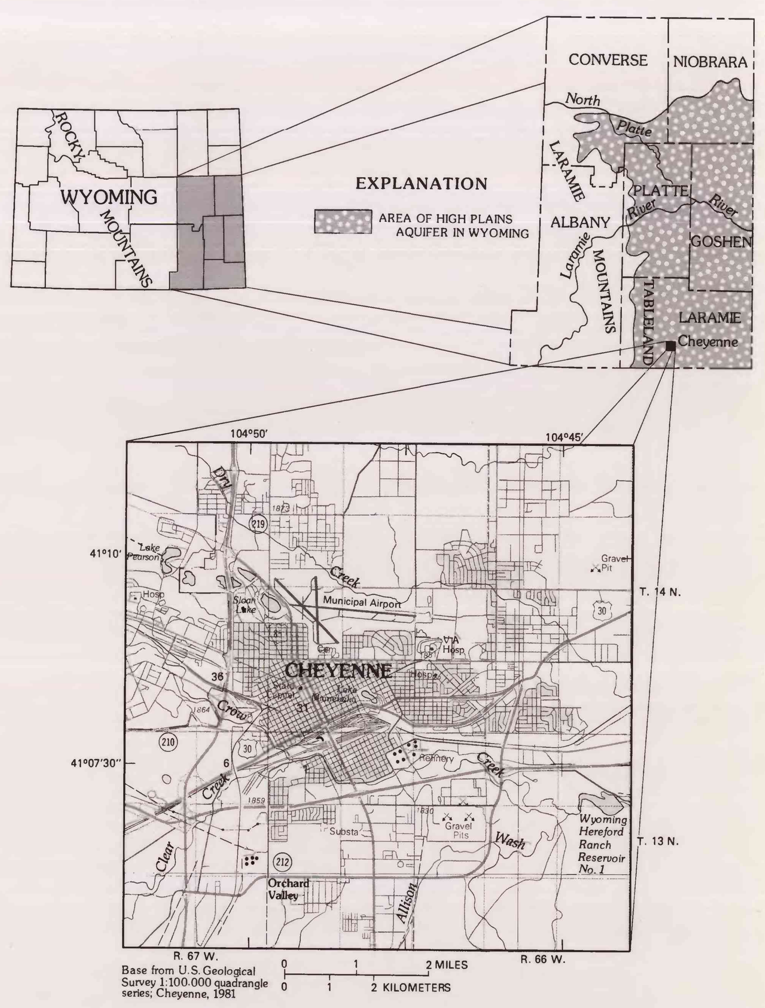

FIGURE 1.--Location of the study area.

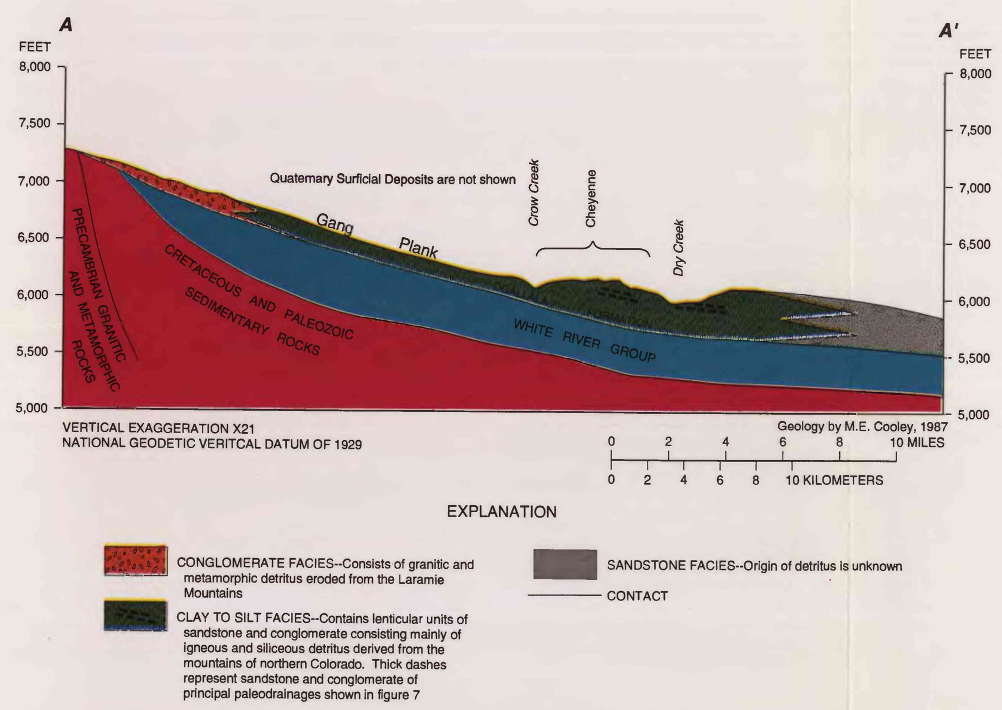

FIGURE 4.--Generalized geologic section showing facies of the Ogallala Formation. Trace of section is shown in figure 3.

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