Satellite photomap of New Mexico

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within one mile of the plane of the section were used. The lithologic pattern shown excludes many details, but is, nonetheless, basically correct. The region is one in which the lithology of some stratigraphic units changes markedly over relatively short distances, so the lithologies shown for these units are more diagrammatic than explicit.

WATER TABLE—The water table is the upper surface of the zone of saturation. Below the water table the rocks are entirely saturated.

To generate the water table shown on the cross sections, I drew a water-table map (scale 1:1,000,000). This map is based on 1) the water-level altitude of shallow wells, 2) the altitude of springs and perennial streams, 3) water-table maps prepared by others, and 4) the state topographic map. We may be sure that the water level in shallow wells approximates the water table. So, for the most part, the data from wells deeper than 100 ft were not used.

Springs and perennial streams are the outcrop of the water table and so are appropriate data points. Because the water table—by definition—must everywhere be below the land surface or be expressed as a lake, stream, spring, or bog, water-table contours were drawn so that they were indeed below the land-surface contour shown on the state topographic map.

The contour interval used reflected the reliability of the data and was 100, 200, or 500 ft. The water table as shown on the cross sections is then a reasonable approximation of the water table to about ± 100 ft for the altitude interval 5,000–6,000 ft, and ± 250 ft for altitudes above 6,000 ft.

HEAD DISTRIBUTION—To determine the head distribution shown on the cross sections, I prepared slab maps as follows:

Altitude interval (ft) From	To	Slab interval (ft)	Contour interval of map (ft)
5,000	5,500	100	100
1,000	5,000	500	500
-6,000	1,000	1,000	500

Data points used were 1) the altitude of water levels in wells that were published in reports of or on file with the U.S. Geological Survey, the New Mexico Bureau of Mines and Mineral Resources, or the New Mexico State Engineer; 2) drill-stem test and bottom-hole pressure data from wells and test holes converted to the altitude of the water level of an equivalent fresh-water column; and 3) altitude of water levels reported by drillers when holes filled with water during drilling.

The 500-ft contour interval has two advantages: first, converting from pressure to fresh-water-level altitudes introduces error. Using a 500-ft contour interval more than offsets any error from this source; and second, in some areas the data were so sparse that only a 500-ft interval reflects the level of accuracy of the resulting contours.

In the region of the basin where irrigation has caused extensive water-level changes the 100-ft contour interval gives more detail. By resorting to 100-ft intervals, I hoped to forestall the problem of water-level change as a result of intermittent pumping.

To draw each cross section, I treated a slab map as if it were a mid-plane map and entered the value of the contours on the mid-plane altitude where it crossed the section. A set of data points that fell on the mid-plane lines resulted for each cross section. The contours shown connect points of equal value.

Through restriction of the contour interval shown to 500 ft, the head distribution becomes general but also represents reality fairly well. That is, the cross sections predict the altitude of the water level in a well (or the equivalent bottom-hole or drill-stem test pressure) to an accurancy of ± 250 ft over most of the area depicted by the cross section.

FLOW PATHS—Flow paths depicted on the cross sections assume that fluid flow, and ground-water flow especially, is from areas of high head toward areas of low head. The flow presumably is more or less at right angles to the iso-head lines. The flow lines are shown for illustration purposes only; they neither constitute a flow grid nor reflect the volume of water flowing along the path.

OIL AND GAS FIELDS—The oil and gas fields shown on the cross section are those that occur within 1 mi of the plane of the section, and the shape reflects the producing intervals of the wells within 1 mi of the plane of the section.

The natural system

Fig. 5 shows diagrammatically in black the features of the natural system suggested by fig. 3.

The ground-water flow system that existed before irrigation and petroleum production was complex. Water flowed from recharge areas on both sides of the Pecos River. The recharge area that provides the ground water that reaches the Pecos River and which once fed the spring discharge at Roswell had its origin in a region west of Roswell, but not so far west that it reached to the surface-water or ground-water divide. Recharge from the west side flowed not only to the Pecos but also appears to have underflowed the river. McNeal (1965) drew some head-distribution maps that suggest movement toward the rivers of west or central Texas. Some underflow probably discharged downstream from the plane of the cross sections.

Water moving from the recharge area east of the river passes through the Rustler and Salado Formations dissolving gypsum and halite. Thus, water along the east side of the river has large concentrations of total dissolved solids.

The recharge area west of the river encompasses large areas of karst topography—a direct result of the solution of limestone and dolomite by the percolating recharge.

Shallow oil fields (for example, Bitter Lakes, Linda, and Pecos) occur along the east side of the Pecos River in stagnation zones where the local flow system east of the river conflicts with the regional system that underflowed the Pecos River.

The cross section through the southern part of the Pecos River drainage basin in New Mex-

(continued on p. 12)

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This map is a product of the latest remote-sensing technology used in the Landsat satellites of the National Aeronautics and Space Administration. Other available editions, published as *Resource Map 12* by the New Mexico Bureau of Mines & Mineral Resources, are listed on p. 5. The mosaic was compiled by the Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture with funds provided by the Bureau.

Since 1972, three Landsats orbiting the Earth 14 times every day at an altitude of 570 mi have gathered a storehouse of scientific data relating to the Earth's surface. These satellites make available for the first time extremely accurate imagery of large areas.

The Landsat's detecting instrument is not a camera but rather a sensor capable of scanning an area 115 mi × 115 mi, called a *scene,* every 25 seconds. The scan lines are closely spaced and at right angles to the line of flight. Because the satellite is in approximate polar orbit, the scan lines on the imagery are roughly east-west (actually N.80°W.-S.80°E.). On the small-scale mosaic, the scan lines are barely visible except across the southernmost region.

The new mosaic of New Mexico was compiled from portions of 33 separate pictures (scenes) selected from the Landsat 2 and Landsat 3 orbits of October 1977 and 1978. In preparing a mosaic, every effort is made to fit adjoining, overlapping pictures so that the match lines resulting from differences in shading are subdued. Only a few match lines are obvious on this small-scale mosaic. The most prominent one courses generally north-south as an irregular line in the east-central region about 100 mi west of the eastern boundary line.

Finding scenes that are relatively free of cloud cover is another concern. In this mosaic the only clouds are a few scattered patches in the vicinity of the Alamo Hueco Mts. in the southwest corner of the state, a small group over the Mimbres Mts., and three small patches over the Sacramento Mts. in the south-central region. Every cloud has a black shadow to the northwest, as do prominent ridges and escarpments. During the summer, profuse vegetation can mask terrane; October is the optimum month for selecting imagery for terrane maps.

The multispectral sensor in the satellite intercepts the total range of radiation from each scene and then separates components of the spectrum into several different bands (wavelengths). The bands used in compiling the New Mexico mosaic are: band 4—visible reflected *green* light; band 5—visible reflected *red* light; and band 7—invisible *near infrared* radiation. The visible green and red bands are best suited for delineating terrane, surface water, and many cultural features; band 7 detects the invisible infrared radiation emitted by growing plants and therefore is ideally suited for delineating vegetational cover. After the bands have been sorted out in the sensor, they are digitized and beamed back to receiving stations on Earth. The total stream of data is stored on magnetic tapes.

When the tapes are inserted in a laser-beam recorder, a scene becomes a black and white picture of the imagery on photographic film—a separate film for each band. The film images are then projected through color filters to form a composite color negative of the scene. Final prints are then processed in the "false" colors seen on the mosaic.

The unconventional colors help identify features that could not be detected in natural color. *Red* indicates active vegetation; the lusher the growth the brighter the tint. Principal mountain ranges are characterized in dark red because of an "evergreen" forest cover. *Black* indicates recent lava flows, deep

water, and shadows. Some basaltic flows are grayish to brownish black; some deep water is bluish black. *Pure white* (if the paper is pure white) indicates clouds and snow. The only snow cover observable in this mosaic is on Sierra Blanca Peak in the south-central region; Truchas, Wheeler, and Big Costilla Peaks in the north-central region; and the San Juan Mts. in Colorado. *White* to off-white also indicates sandy areas, dunes, playas, arroyos, cultivated fields, cleared land, disposal sites, and dormant meadows. Small patches of *turquoise blue* are bodies of turbid, shallow water. Extensive *blue-green* areas are mostly barren rock or stony slopes with sparse, scrubby vegetation; bedrock outcrops tend to be darker (as on mountains) whereas unconsolidated stony deposits tend to be lighter. *Light tan* to buff indicates a thin mantle of windblown sand with a high percentage of red grains.

0 20 40 60 80 100 MILES

A subsequent issue will contain a brief discussion of the geologic features discernible on the new mosaic. □

—*Robert W. Kelley*