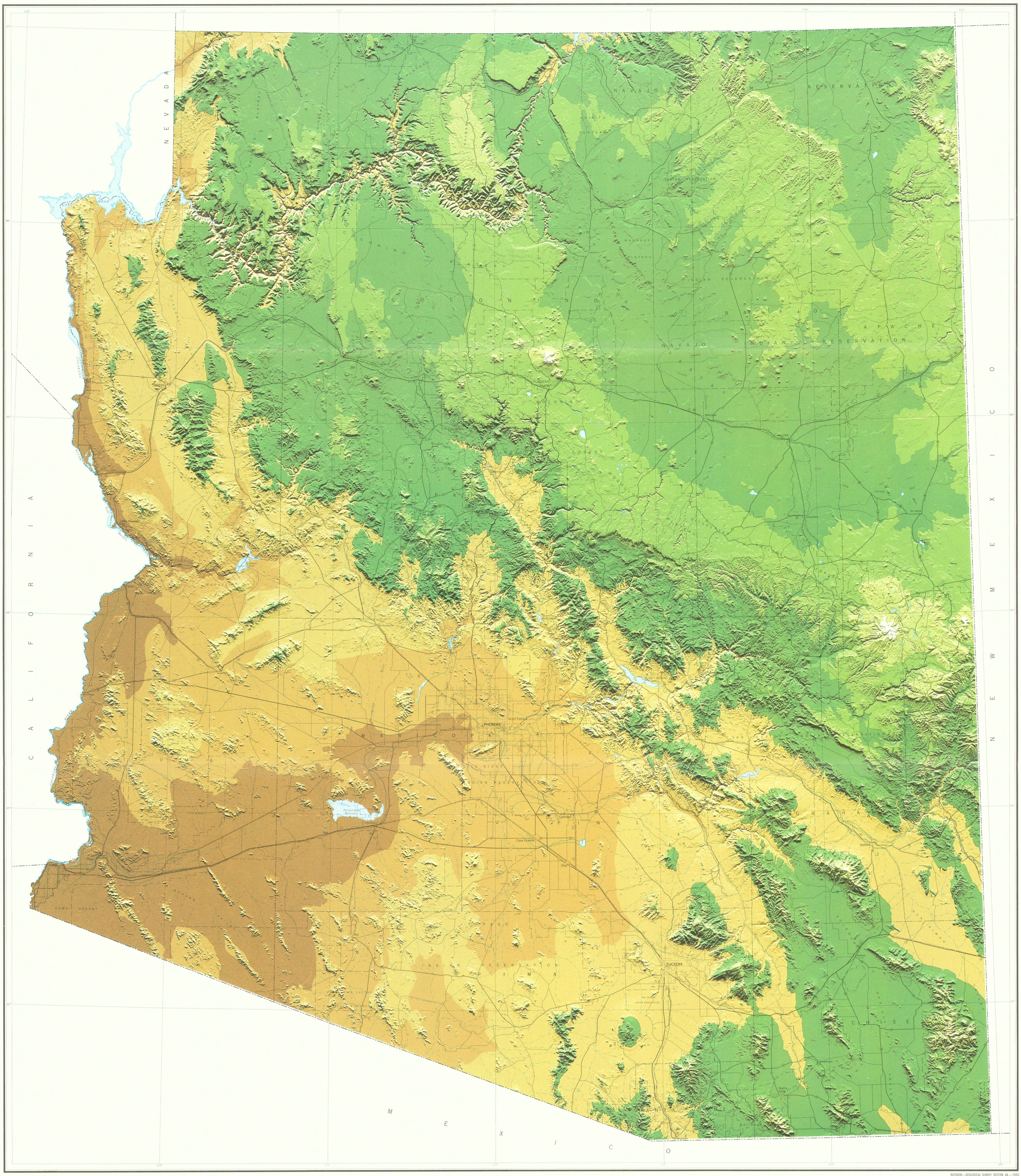
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
1:1,000,000 EXPERIMENTAL SHADED RELIEF
ARIZONA
MAP I–1821 (SHEET 1 OF 2)



Planimetric base from U.S. Geological Survey, 1:500,000, State of Arizona, 1972 (revised 1981)

Selected place names are shown solely to facilitate user orientation. The nomenclature is by no means complete, and no implication of geographic importance is intended

Lambert Conformal Conic projection based on standard parallels 33° and 45°

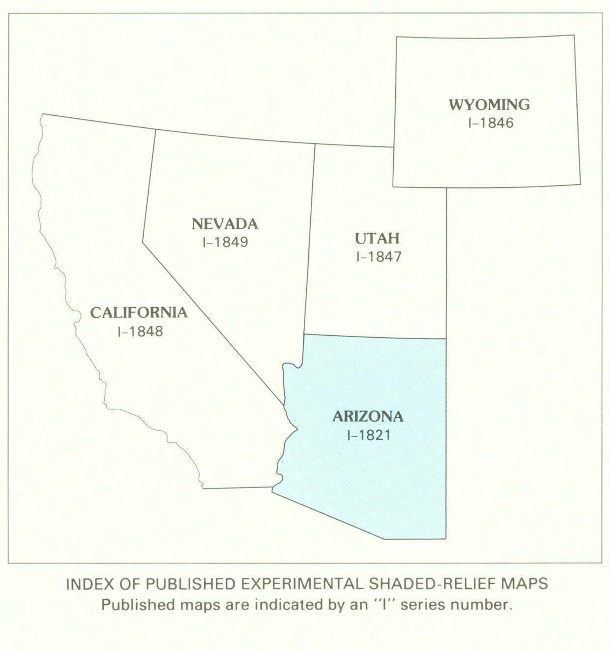
SCALE 1:1 000 000
1 centimeter equals 10 kilometers

25 0 25 50 MILES

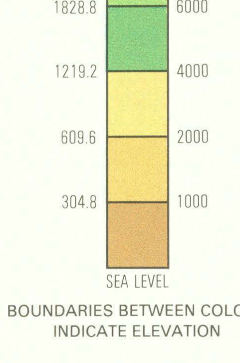
25 0 25 50 75 KILOMETERS

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1990

Compiled by Kathleen Edwards and E.M. Sanchez, 1983-84



INDEX OF PUBLISHED EXPERIMENTAL SHADED-RELIEF MAPS
Published maps are indicated by an "I" series number.



BOUNDARIES BETWEEN COLORS
INDICATE ELEVATION

NOTES ON MAPS

The relief on these maps is portrayed by computer methods (Batson and others, 1975) that use an array of known topographic elevations (digital elevation model, or DEM) to compute a theoretical reflectance value for slope segments between each pair of elevation values on the basis of any specified solar-illumination angle. Shaded-relief maps are conventionally illuminated from the northwest at an elevation of 45° above the horizon (Horn, 1981). For this map, however, a Sun azimuth of 0° (due north) and an elevation of 30° above the horizon were chosen in order to minimize artifacts created by the interpolation methods used in the DEM mosaic and to depict the best apparent positive relief. The elevation of the Sun determines the contrast of the image; because contrast can be modified by other means, the elevation is not critical. The DEM used for this map consists of a grid of elevation values at 150-m intervals.

DEM blocks with dimensions of 1° in latitude by 1° in longitude were originally compiled by the Defense Mapping Agency Topographic Command (DMATC) by digitizing contour lines on 1:250,000-scale quadrangles. DMATC interpolated elevation values every 0.01 in. (approximately 60 m) at map scale and formed a raster of rows and columns of elevation values. Each model was encoded in Transverse Mercator coordinates.

A regional DEM was then compiled by making a mosaic of these blocks. This compilation required significant refinement and reprocessing of the original data. For example, the boundaries of each block had to be identified precisely so that spurious data outside the block could be discarded and so that the block could be accurately positioned in the digital array that formed the mosaic. Strings of data points were occasionally lost during original compilation; these dropouts were identified and new values from adjacent data points were interpolated. Discontinuities between blocks were smoothed by special image-processing methods. Each block was transformed to a Lambert Conformal Conic projection and resampled from the original grid to a spacing of 150 m per elevation value. Because of the interpolation methods and numerous photomechanical steps required to produce this map, the digital image does not precisely fit the planimetric base in some marginal areas. These marginal areas appear as white.

The color-coded elevation version (sheet 1) shows zones of elevations in color superimposed on the black-and-white shaded relief. Most shaded-relief maps do not depict actual elevation through color, but the color elevations were added here to help provide a sense of the real relief. It should be noted, however, that relief shading necessarily distorts elevation color codes, especially on shaded or directly illuminated slopes. Colored elevation zones conventionally range from green for the lower elevations to brown for the higher; white is not normally used. The unconventional color coding applied to the elevation zones for this map was designed by Kathleen Edwards, R.M. Batson, and E.M. Sanchez for visual effect only and is not intended to represent actual surface coloration.

The digital shaded relief (sheet 2) is shown without culture and drainage so that the physiographic features are not obscured.

REFERENCES

Batson, R.M., Edwards, Kathleen, and Eliason, E.M., 1975, Computer-generated shaded relief images: U.S. Geological Survey Journal of Research, v. 3, no. 4, p. 401–408.
Horn, B.K., 1981, Hill shading and the reflectance map: Proceedings of the Institute of Electrical and Electronics Engineers, v. 69, no. 1, p. 14–47.

DIGITAL SHADED RELIEF WITH COLOR-CODED ELEVATIONS
EXPERIMENTAL DIGITAL SHADED-RELIEF MAPS OF ARIZONA

By

Kathleen Edwards and R.M. Batson

1990

For sale by U.S. Geological Survey, Map Distribution, Box 25286, Federal Center, Denver, CO 80225