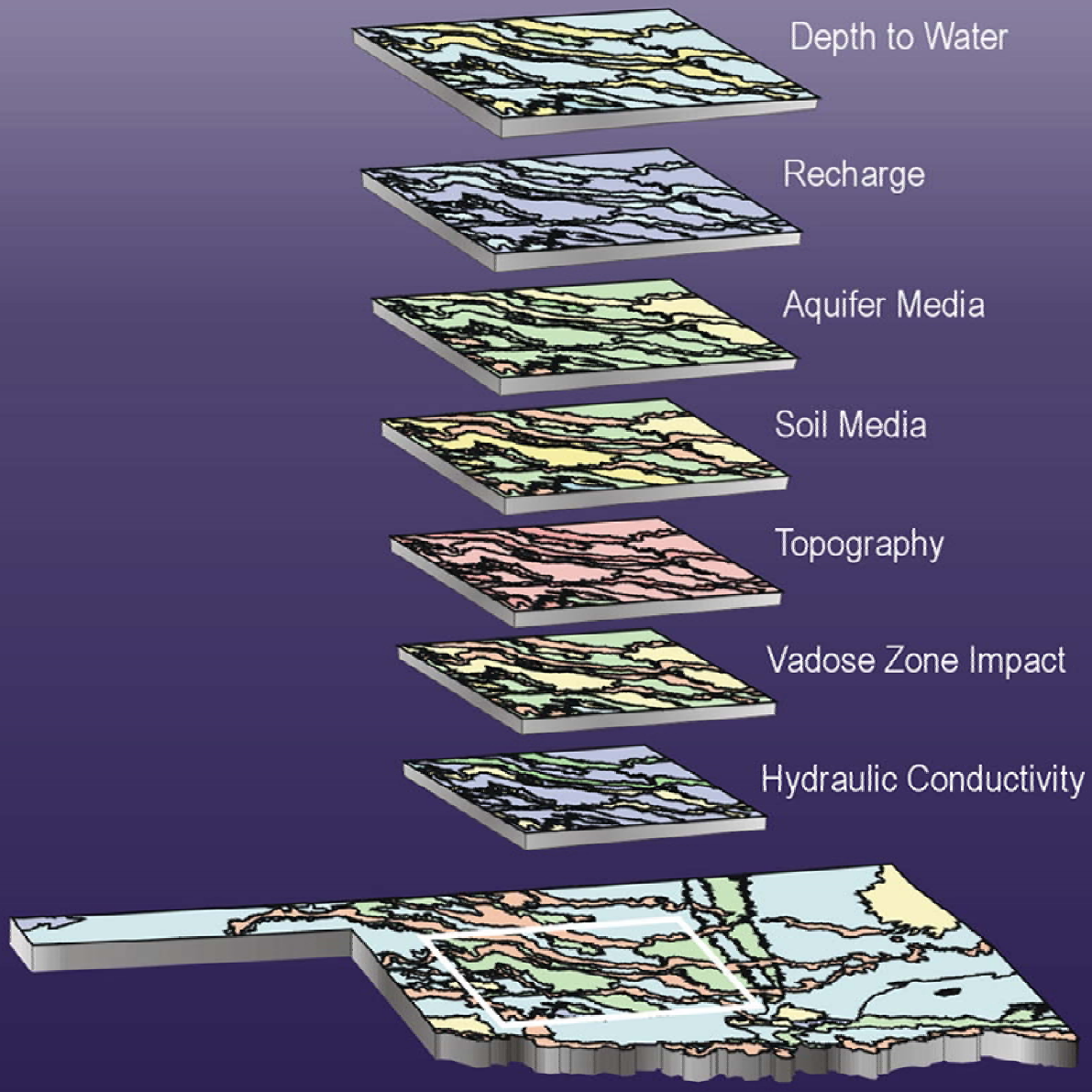
STATEWIDE GROUNDWATER VULNERABILITY MAP OF OKLAHOMA



By
Noël I. Osborn and Ray H. Hardy

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All groundwater is vulnerable to contamination from surface sources of pollution; however, some areas are more vulnerable than others. The Oklahoma Water Resources Board (OWRB) developed a map showing the relative vulnerability of groundwater in 30 hydrogeologic basins in Oklahoma that are exposed at land surface, and are thus more likely to be susceptible to pollution. Vulnerability was computed with the DRASTIC index method, developed by the U.S. Environmental Protection Agency (EPA). Based on the DRASTIC indices, the hydrogeologic basins were classified in five groups of relative vulnerability: very low, low, moderate, high, and very high. The vulnerability map shows that the alluvium and terrace deposits are most susceptible to pollution of groundwater; the igneous and low yielding bedrock basins are the least susceptible.

Introduction

PURPOSE

The purpose of this investigation was to develop a statewide map showing the relative vulnerability of groundwater to surficial contamination that could be incorporated into Oklahoma's water quality standards.

BACKGROUND

The OWRB and the U.S. Geological Survey (USGS) conducted a vulnerability assessment of 12 major Oklahoma aquifers using the DRASTIC index method. Twelve major aquifers, for which adequate data were available from previous studies, were selected for the assessment. These aquifers are listed below and are displayed in Figure 1:

Bedrock Aquifers:

- Central Oklahoma
- Vamoosa-Ada
- Rush Springs
- Antlers
- Elk City
- High Plains

Alluvium and Terrace Deposits:

- Enid Isolated Terrace
- Tillman Terrace
- Cimarron River
- North Canadian River:
  - ------ western reach from the Panhandle to Canton Lake
  - ------ central reach from Canton Lake to Lake Overholser
  - ------ eastern reach from Oklahoma City to Eufaula Lake

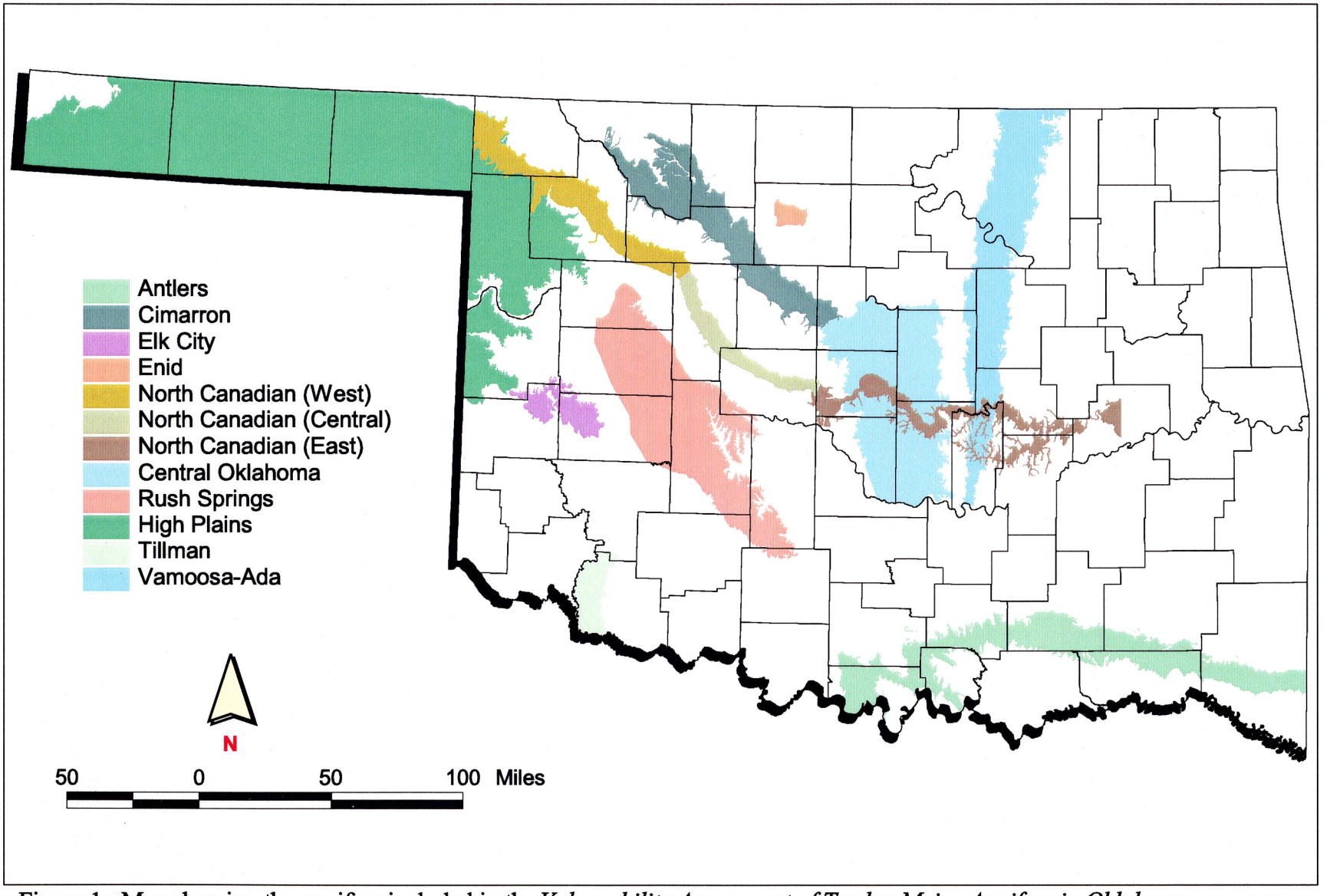

Figure 1. Map showing the aquifers included in the *Vulnerability Assessment of Twelve Major Aquifers in Oklahoma* (Osborn and others, 1998).

The USGS created, documented, and published digital geospatial data sets that describe the aquifer characteristics and created the grid layers used to calculate the DRASTIC index. The OWRB used the grid layers created by the USGS to compute the final DRASTIC indices and to produce the aquifer vulnerability maps. The maps are based on a cell size of 960 x 960 meters, or about 228 acres.

The resulting aquifer vulnerability maps indicate that of the 12 major aquifers included in the assessment, the bedrock aquifers are the least vulnerable to contamination from pollutants introduced at the ground surface, and the alluvium and terrace deposits are the most vulnerable. The High Plains aquifer is only moderately vulnerable, largely due to its great depth to water. For more information on this study, refer to the OWRB technical report 98-5: *Vulnerability Assessment of Twelve Major Aquifers in Oklahoma* by Osborn and others, 1998. The report is also available on the OWRB website (www.state.ok.us/owrb).

The vulnerability maps provide valuable information on the relative vulnerability within the 12 major aquifers. However, the assessment represents only a portion of the groundwater in the state, and is not, in itself, adequate to be incorporated into Oklahoma's water quality standards. Recognizing that the quality and resolution of data available for the 12 major aquifers are not currently available for the remainder of the state, and that collecting such data would be expensive and time-consuming, the OWRB developed a regional approach to produce a statewide vulnerability map.

Hydrogeologic Basins

Groundwater is water that has percolated downward from the surface, filling voids or open spaces in the rock formations. An aquifer is a subsurface unit that can yield useful quantities of water. Oklahoma's aquifers may be divided into two general groups: bedrock and alluvium and terrace deposits. The bedrock aquifers include sandstone aquifers; interbedded sandstone, limestone, and shale aquifers; soluble carbonate and evaporite (limestone, dolomite, and gypsum) aquifers; and the semi-consolidated sand and gravel that comprise the Ogallala aquifer. The alluvium and terrace deposits consist of unconsolidated deposits of sand and gravel along rivers and streams.

The OWRB considers major aquifers, or groundwater basins, to be those bedrock aquifers that can yield on average at least 50 gallons per minute (gpm), and those alluvium and terrace deposits that can yield at least 150 gpm. Minor aquifers yield less water. Oklahoma is underlain by 23 major aquifers containing an estimated 320 million acre-feet of water in storage. Many minor aquifers also yield significant amounts of fresh water.

To develop a statewide groundwater vulnerability map, the OWRB subdivided the state into 30 hydrogeologic basins. As used in this report, a *hydrogeologic basin* is a mappable geologic unit that is exposed at land surface and that has common hydrogeologic characteristics such as lithology, topography, and well yield.

Because only geologic formations exposed at the surface are included in the hydrogeolgic basins, portions of aquifers (such as the Central Oklahoma, Rush Springs, Antlers, Arbuckle-Simpson, and the Arbuckle-Timbered Hills) overlain by shallower formations are not included in the basins. The Roubidoux aquifer, in northeastern Oklahoma, is not included in the vulnerability assessment because it is entirely in the subsurface, underlying the Boone and Pennsylvanian hydrogeologic basins.

Of the 30 hydrogeologic basins, 19 consist of bedrock; 10 are major alluvium and terrace aquifers; and one includes all the remaining alluvium and terrace deposits. The hydrogeologic basins are listed in Table 1 and are displayed in Figure 2. Each basin is described in Appendix A.

Boundaries for the hydrogeologic basins shown in Figure 2 were extracted from existing digital maps of varying levels of resolution. Most of the bedrock basin boundaries were derived from the USGS regional geology map of Oklahoma, which is part of a map showing the surficial geology of the United States at a 1:2,500,000 scale (Schruben and others, 1994). Boundaries for the Rush Springs, Blaine, and Cedar Hills basins and the major alluvium and terrace basins were derived from OWRB maps showing major groundwater basins. The OWRB maps were digitized from various 1:250,000 scale-maps. The boundaries for the Vamoosa-Ada, Enid Isolated Terrace, Elk City, and Central Oklahoma basins were derived from USGS digital data sets, based on a scale of 1:250,000 (Abbott and others, 1997; Becker and others, 1997a,b; Runkle and Rea, 1997).

Figure 2 is a generalized map showing the hydrogeologic basins. To determine site-specific boundaries, refer to the basin descriptions in Appendix A, and locate the site on the surficial geology maps published in the hydrologic atlases of Oklahoma (Bingham and Bergman, 1980; Bingham and Moore, 1975; Carr and Bergman, 1976; Hart, 1974; Havens, 1977; Marcher, 1969; Marcher and Bergman, 1983; Marcher and Bingham, 1971; Morton, 1980; Morton and Goemaat, 1973; Sapik and Goemaat, 1973; Wood and Hart, 1967). The digital surficial geology sets from the hydrologic atlases are available on the Internet at http://wwwok.cr.usgs.gov/gis/geology/index.html (Cederstrand, 1996a,b,c,d,e,f,g,h,i,j,k,l).

The hydrogeologic basin that includes all other alluvium and terrace deposits is not shown in Figure 2 because a digital map is not available for all of the alluvium and terrace deposits in the state, and because the density of detail of the alluvium and terrace deposits is too high to be represented on a generalized map. Alluvium, terrace deposits, and dune sands for which digital data sets were available are displayed in Figure 3. This map was created from the digital surficial geology sets. Digital data sets for the alluvium and terrace deposits in the Ardmore and Sherman quadrangles were not available. To identify the alluvium and terrace deposits in this area, refer to Sheet 1 in Hydrologic Atlas 3 (Hart, 1974).

Table 1. List of hydrogeologic basins

Bedrock	Alluvium and Terrace Deposits
Central Oklahoma	of the Salt Fork of the Arkansas River
Vamoosa-Ada	of the Arkansas River
Rush Springs	of the Cimarron River
Antlers	of the North Canadian River
Elk City	of the Canadian River
Ogallala	of the Washita River
Cedar Hills	of the North Fork of the Red River
Blaine	of the Red River
Arbuckle-Simpson	Enid Isolated Terrace
Arbuckle-Timbered Hills	Gerty Sand
Arkansas Novaculite	all other alluvium and terrace deposits
Mesozoic	
Permian	
Cretaceous	
Boone	
Pennsylvanian	
Ouachita Mountains	
Tishomingo Granite	
Washita Igneous	

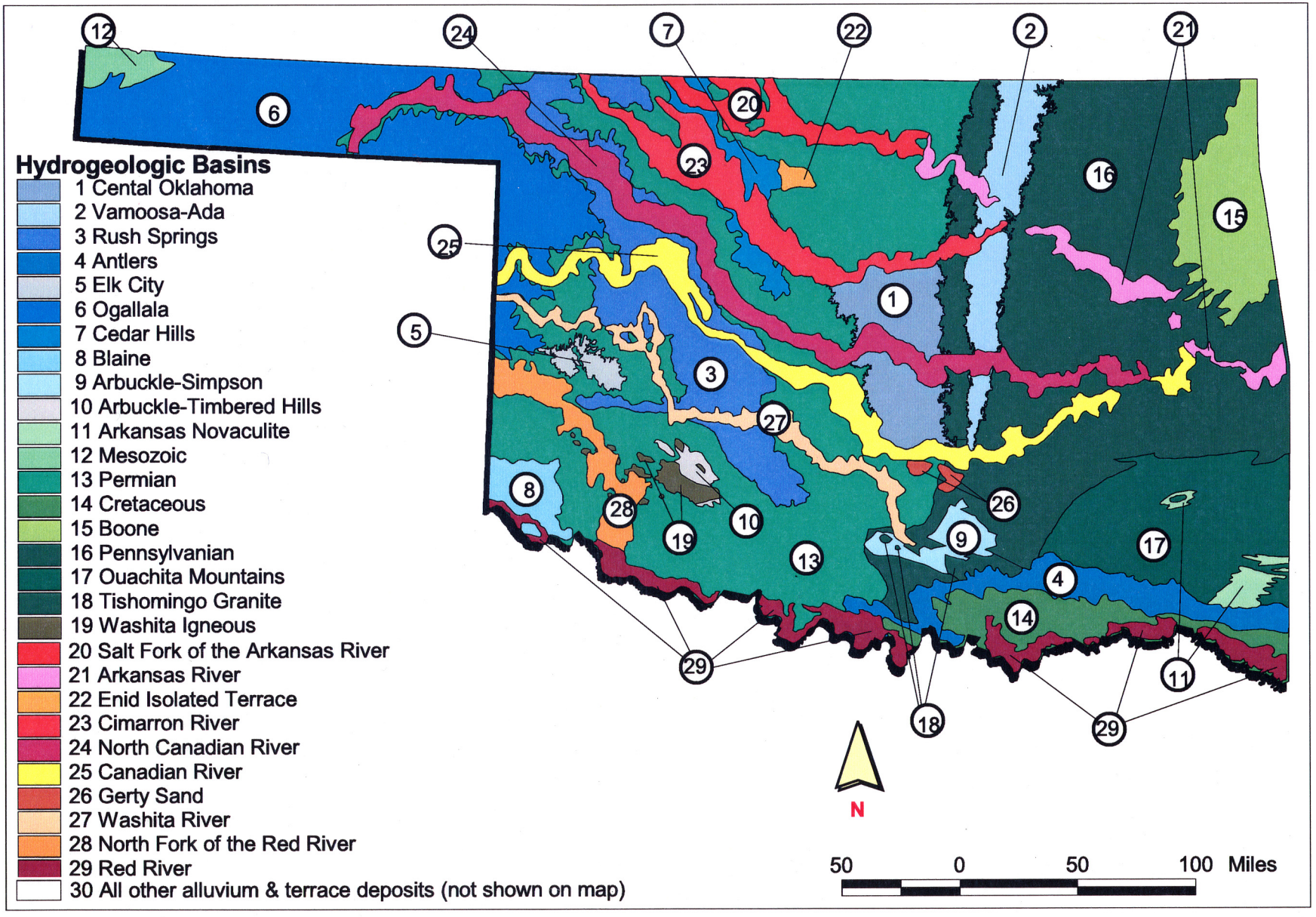

Figure 2. Generalized map showing the hydrogeologic basins.

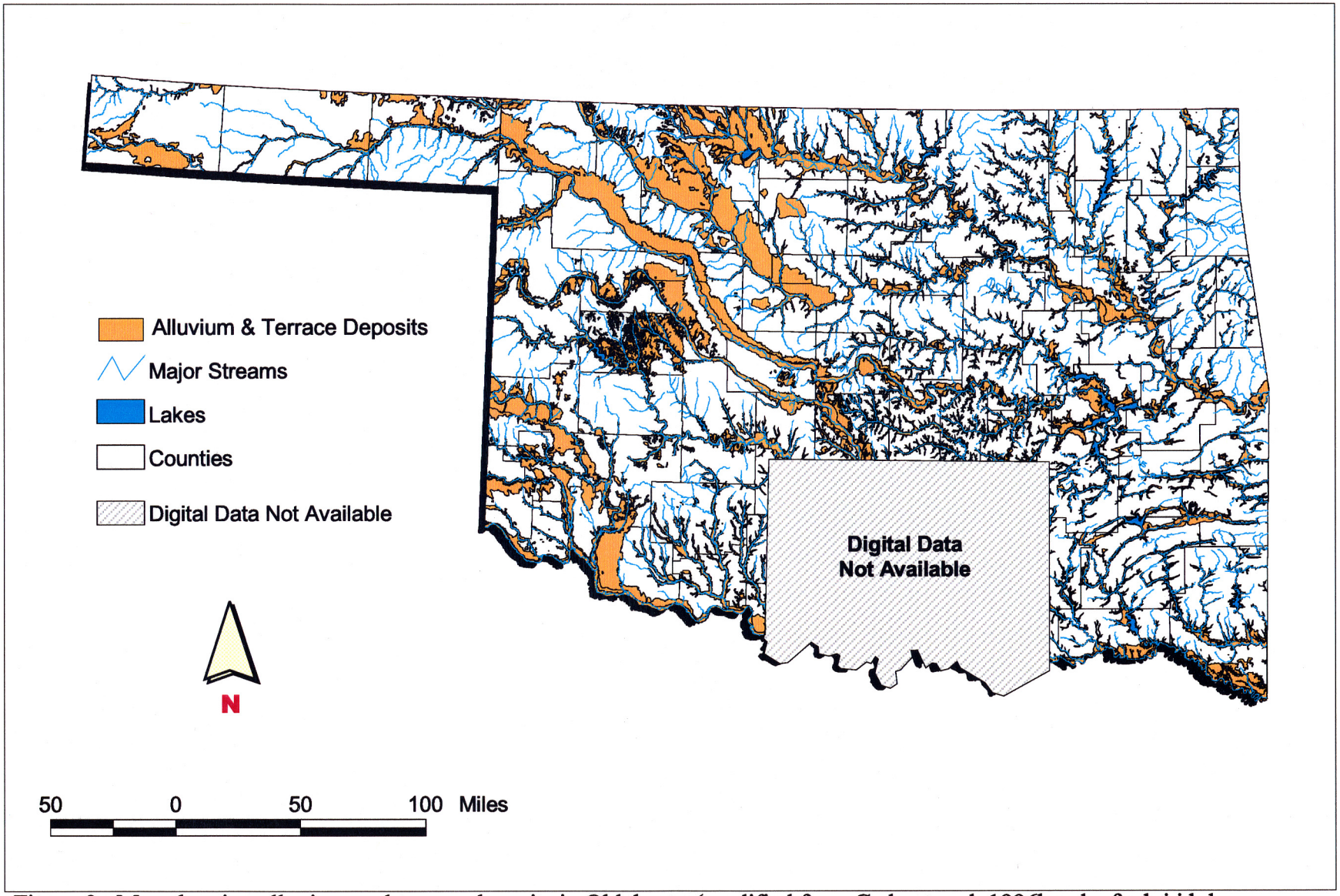

Figure 3. Map showing alluvium and terrace deposits in Oklahoma (modified from Cederstrand, 1996b,c,d,e,f,g,h,i,j,k,l; 1:250,000-scale maps).