# GEOLOGIC FRAMEWORK

Topography, geology and soils affect the availability of surface- and ground-water resources. These factors largely determine the proportion of precipitation which runs off the land to become surface water, as opposed to that which infiltrates into the soil and percolates through underlying materials to become ground water.

The geologic timescale (fig. 6) illustrates the sequence of geologic events for Indiana and the rock types associated with each geologic period. During the Pleistocene Epoch (Ice Age), glacial lobes repeatedly entered Indiana. The glacial lobes entered the state from at least two directions: from the northeast out of the Lake Erie and Saginaw Bay basins, and from the northwest out of the Lake Michigan basin (fig. 7). Advancing glaciers scoured the land surface while retreating glaciers left behind large deposits of scoured materials. Erosion has subsequently modified the glacial deposits to produce currently existing landforms.

This glacial and post-glacial activity has been the predominant influence upon the present topography and surficial geology of the St. Joseph River basin. Glacial deposits, some as thick as 450 feet (fig. 8), cover the basin bedrock as a legacy of the most recent period of glaciation. Land surface elevation ranges from 665 feet m.s.l. (mean sea level) near South Bend to 1205 feet m.s.l. north of Angola. Local topographic relief in areas containing kame deposits may exceed 200 feet.

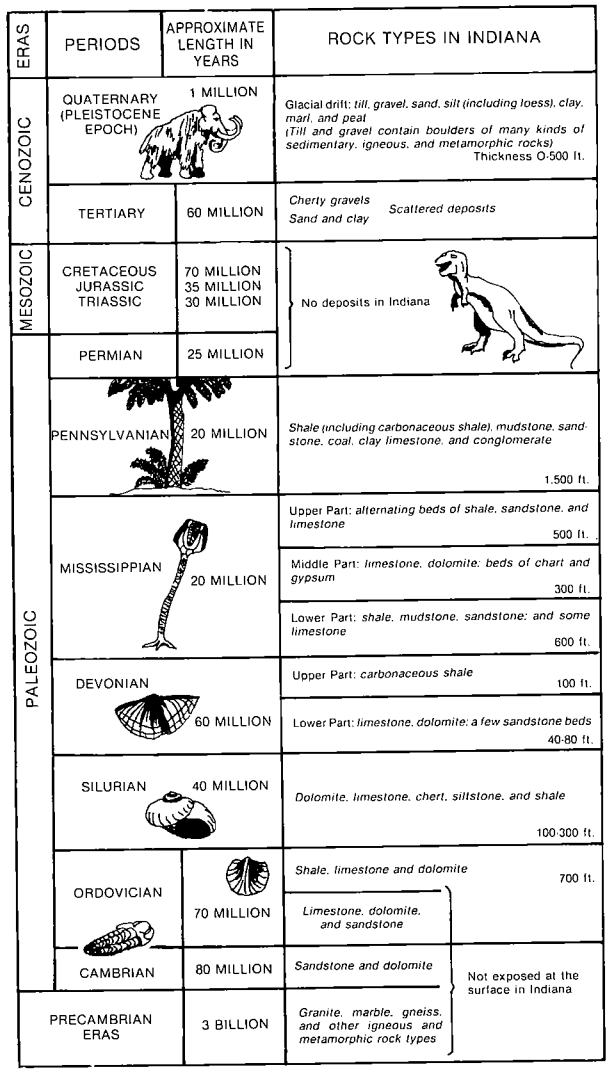


Figure 6. Geologic Timescale for Indiana

## TOPOGRAPHY

The St. Joseph River basin is characterized by complex topographic features that include moraines having rugged topography and relatively level till plains interspersed among braided meltwater (outwash) channels and hummocky ridges. This terrain includes small enclosed basins occupied by lakes or marshes, as well as broad pitted outwash fans. Simpler topographic features include the broad, level till plain of the Wakaruska-Wyatt-Nappanee area and the wide coalesced outwash surfaces of the St. Joseph River valley itself. The basin's topographic complexity suggests the complexity of distribution of Quaternary sediment types, which in turn relates to the complex glacial history.

The basin can be subdivided into six regions on the basis of topography and distribution of surface sediments. The southern margin of the basin is defined by the combined Mississinewa and Packerton Moraines (fig. 9, region 1). The southwestern part of the moraines is characterized by sag and swell topography having as much of 40 feet of relief. There are many lakes in the northwestern part of the morainal area, many of which are more than 50 feet deep. Sediments within these moraines consist of a heterogeneous assemblage of both clayey basal melt-out and flow tills of the Lagro Formation, sand and gravel outwash, and lake muds juxtaposed both vertically and laterally.

The northwestern flank of the morainal area is cut by open channel heads and probable collapsed ice

trough cut into till (fig. 9, region 2, white pattern). The channels trend at right angles away from the morainal area and coalesce into an apron. Some channels remain active, especially those that are part of the channel system of the main tributaries within the St. Joseph River basin. The channels are filled with outwash sand and gravel that is overlain in places by organic muds and peat. The presence of closed basins within the St. Joseph basin suggests that the original longitudinal profiles of the channels have been disturbed by events subsequent to channel formation.

Northwest of the previously mentioned apron, the outwash channels coalesce to form broad outwash plains that are laterally extensive along the moraine front (fig. 9, region 3). The outwash deposits are interrupted locally by hummocky ridges of morainal material and ice-contact deposits. These outwash materials are inset within remnants of the loamy till that underlie the more clayey tills in the moraines of the Erie Lobe.

Outwash deposits extend northwestward and northward into a broad lowland that can be subdivided into two parts. The northeastern part (fig. 9, region 4a) has a complex array of gravel-filled outwash channels, ground moraine composed of loamy till, and hummocky ridges that may represent minor moraines and/or ice-contact deposits of the Saginaw Lobe. The southwestern part (fig. 9, region 4b) is characterized by larger outwash channels that are now valleys of major tributaries of the St. Joseph River, including the Elkhart, Little Elkhart and Pigeon Rivers.

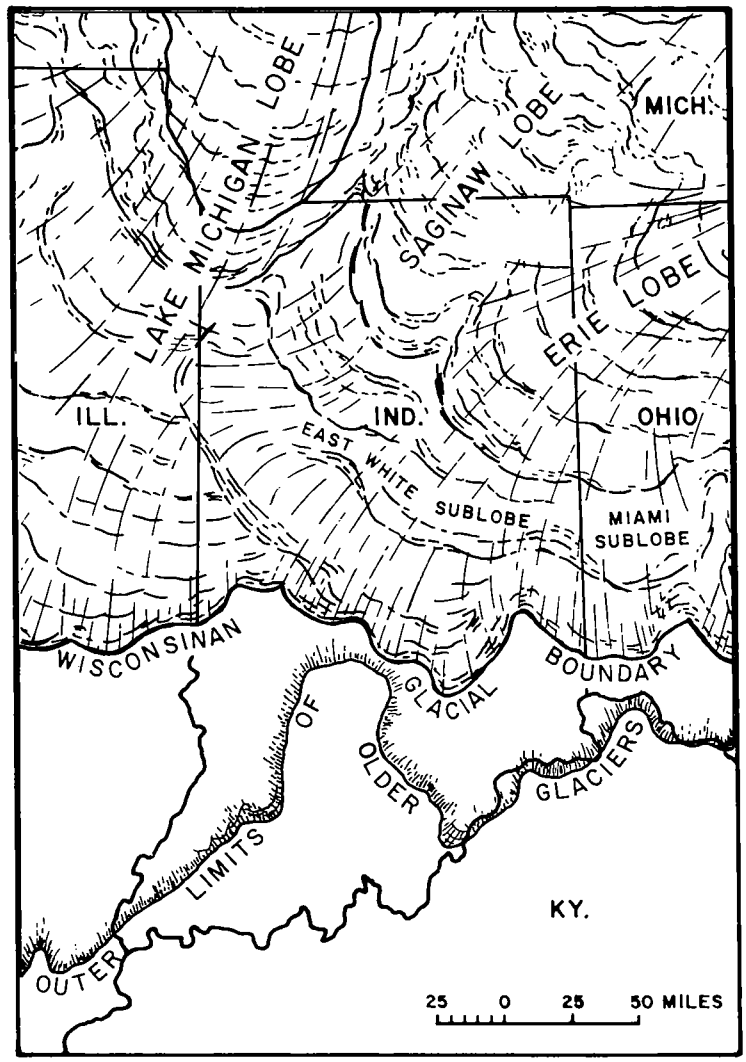


Figure 7. Major Ice Lobes during Wisconsinan Age

The lowland to the southwest, however, is occupied by a more extensive plain that is cut by few channels (fig. 9, region 5). Only the northern part of this till plain lies within the St. Joseph River basin. The plain is bounded on the west by the Maxinkuckee Moraine, which has been considered to be the terminal moraine of the Saginaw Lobe and which possesses rugged topography with numerous closed basins.

The Kankakee Lowland (fig. 9, region 6), is a broad, flat region that extends from Illinois, across northwestern Indiana, and into southwestern Michigan. That part of the lowland extending southwestward from South Bend is now the floodplain of the Kankakee River. That part extending east of South Bend is now occupied by the St. Joseph River. The lowland forms an exceptionally level plain covered by fine-grained Holocene alluvium that is underlain by thick outwash sand and gravel which in turn overlie lake muds.

Soils in the St. Joseph basin generally fall within one of three classes: 1) sandy or loamy soils developed on outwash and allumium; 2) silty or clayey soils developed on till; and 3) muck soils developed in depressional wetland areas. Descriptions of soil associations are given in app. 3.

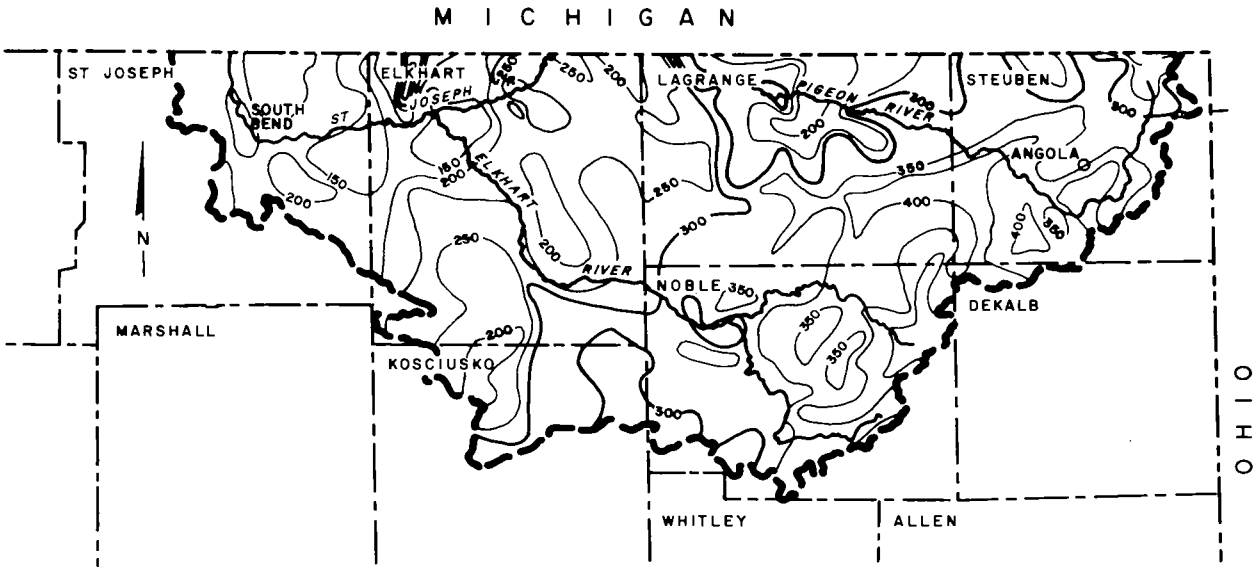


Figure 8. Thickness of Unconsolidated Materials

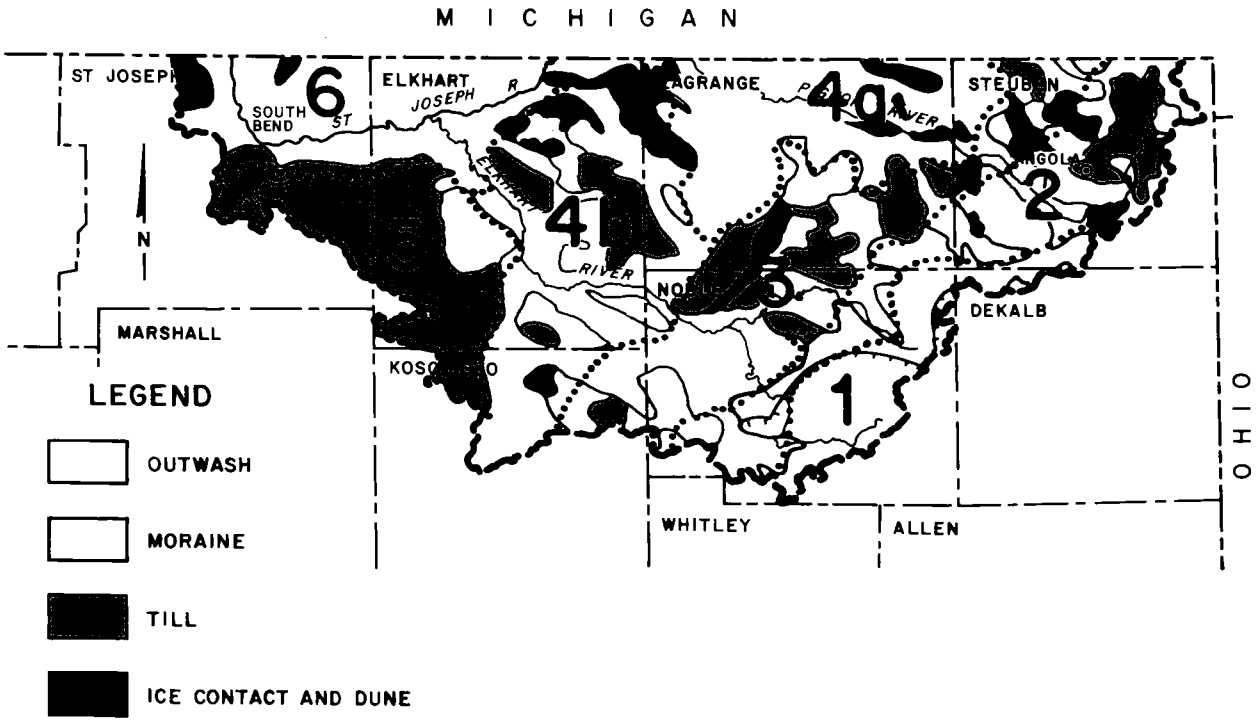


Figure 9. Geomorphic Regions

## GLACIAL GEOLOGY

The surficial geology of the St. Joseph River basin reflects a very complex glacial history. Interpretations of geomorphology and soils have resulted in revised mapping of surficial materials (Gray, in preparation). Insights from this mapping, combined with knowledge from existing geologic and topographic maps, have yielded a hypothesized sequence of glacial events in the St. Joseph basin.

This hypothesis, which includes a concept presented as early as 1883 that northeastern Indiana is an area of interlobate relationships, assumes that the present topography is entirely of Wisconsinan age materials. (Little is known of relationships of earlier glacial material due to a lack of subsurface stratigraphic data.)An outline of the hypothesized events is presented in table 2 and related to the map in fig. 10.

TABLE 2.
Relationships of Quaternary Stratigraphic Units and Hypothesized Glacial and Drainage Events

| AGE | FORMATION MEMBER | GLACIAL LOBE: LAKE MICHIGAN | EASTERN UNDIFF. | ERIE | SAGINAW | DRAINAGE ROUTE |
|---|---|---|---|---|---|---|
| | Largo Fm. | | Clayey till southern Noble Co. (event 6) | | | Northeast to the St. Joseph and Kankakee rivers through pre-existing troughs |
| | Wedron Fm. | Ice-contact proximal fans, tectonic structures(?), southern St. Joseph valley margin (event 5) | | | | Southward, down pre-existing troughs to the Tippecanoe and Wabash rivers |
| | Trafalgar Fm., upper tongue | | | Loamy tills and ice-contact deposits; exemplified by the Ligonier-Topeka-LaGrange line of ice contact deposits (event 4) | | Northeast to the St. Joseph and Kankakee rivers through pre-existing troughs; exemplified by the massive fan at Topeka |
| | unassigned | | | | Sandy and clayey tills of uplands, Elkhart, LaGrange counties (event 3) | Westward as ice-prominal fans on uplands; ice-frontal lateral drainage in troughs between ice (on northeast) and ice-contact slopes (on southwest), northwestward to St. Joseph and Kankakee rivers |
| | unassigned | | Sandy tills of Nappanee area westward (event 2) | | | (ice covered) |
| | Wedron Fm., Snider Till Mb. | Clayey till, subsurface of Wyatt area (event 1) | | | | Eastward, up St. Joseph River, thence south (routes unknown) to Wabash River |

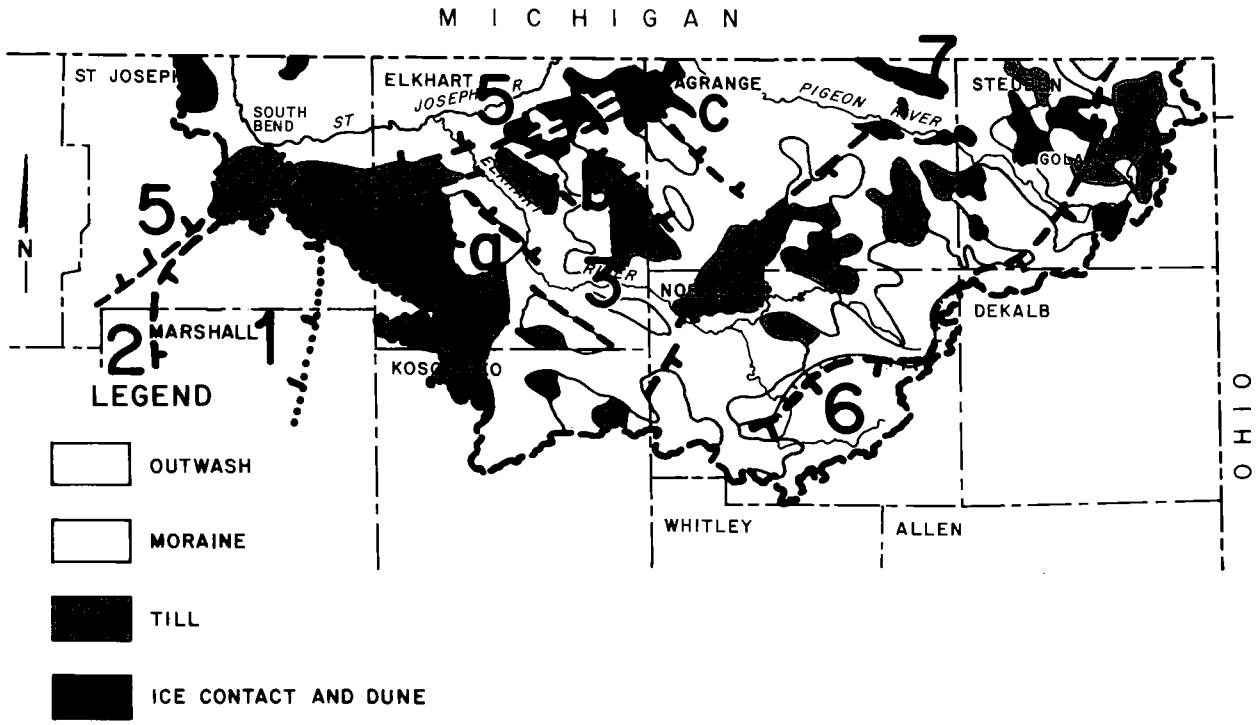


Figure 10. Sequence of Wisconsinan Glacial Events

## BEDROCK GEOLOGY

The bedrock underlying the St. Joseph River basin in Indiana consists mainly of layered Paleozoic limestone, dolomite, sandstone, siltstone and shale, which represent deposits of ancient inland seas. Beneath these rocks are Precambrian igneous basement rocks composed mainly of granite, basalt and arkose. All of these rocks are deformed regionally to form the Kankakee and Cincinnati Arches (fig. 11), which together are a bedrock structural high that extends from northwestern through southeastern Indiana. Along the northern side of this high, including the St. Joseph basin, the sedimentary formations dip about 30 feet per mile to the northeast into the major structural feature called the Michigan Basin. The rocks at the bedrock surface become progressively younger toward the northeast.

Bedrock is covered by a thick mantle of glacial drift and does not appear at the modern land surface anywhere in the drainage basin. Therefore, knowledge of bedrock is based on logs of exploratory drilling, mostly for oil and gas.

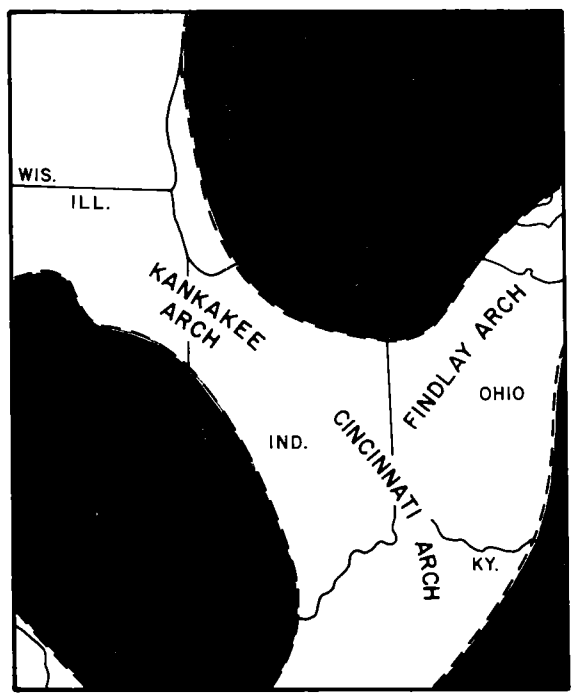


Figure 11. Regional Geologic Structure

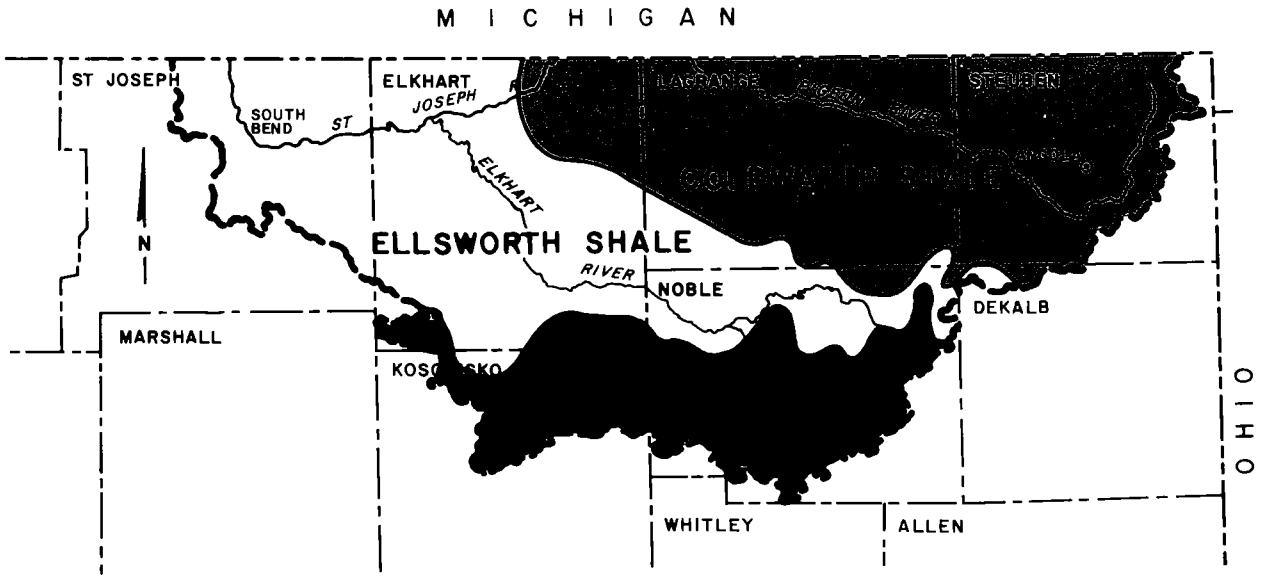


Figure 12. Areal Distribution of Bedrock Units

An exploratory well in Steuben County provides an exemplary section of bedrock formations in that part of the basin where the sedimentary bedrock section is thickest. Here, 450 feet of glacial material overlies about 4450 feet of sedimentary rock sequence (app. 4) that in turn overlies granitic basement rocks. The sedimentary rock sequence ranging between the uppermost and lowermost units, the Coldwater Shale and the Mt. Simon Sandstone, respectively, spans Mississippian through Cambrian time, from about 360 million to more than 600 million years ago.

Three major shale units generally constitute the bedrock surface within the St. Joseph River basin (fig. 12). The slightly silty, gray to greenish-gray Coldwater Shale lies in the northeast. In much of the western and south-central parts of the basin, alternating beds of black and gray-green Ellsworth Shale form the bedrock surface. The brownish-black, noncalcareous Antrim Shale lies to the south. Detailed descriptions of these and other St. Joseph basin bedrock units are given in app. 4.

## BEDROCK TOPOGRAPHY

Depth to bedrock is highly variable within the St. Joseph River basin, ranging from less than 30 feet in the Mishawaka area to nearly 500 feet in the eastern part of the basin. This variability is due to an eroded, irregular shale bedrock surface and a complex series of glacial deposits.

Bedrock elevations range from over 900 feet m.s.l. (mean sea level) in Steuben County to less than 350 feet m.s.l. near Elkhart where a deep narrow valley is present (fig. 13). Deeply incised valleys similar to the one near Elkhart are expected for other portions of the basin.

Because most water wells and test wells are completed in glacial materials, depth-to-bedrock data are lacking. Fig. 13 is therefore a generalized depiction of a diverse bedrock surface having rugged hills and V-shaped valleys.

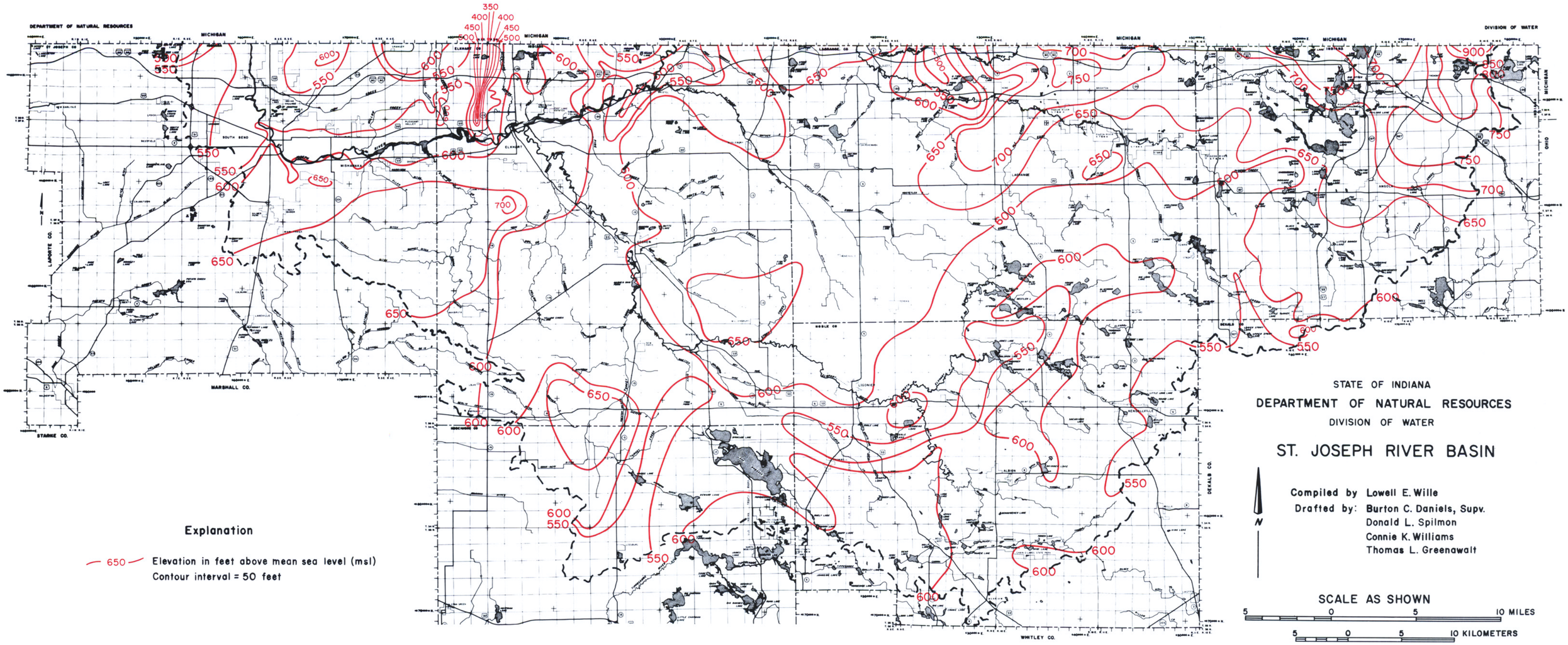


Figure 13. Bedrock Topography