

## PALEOZOIC KARST TOPOGRAPHY

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Karst topography is that unique physiographic expression which is characterized by surficial sinks, "lost" rivers, natural tunnels or bridges, subsurface solution channels, and subterranean caverns. The name "Karst" was applied because of the remarkable development of this type of topography in the Karst or Carso plateau of Austria.<sup>1</sup>

Since it results from solution, karst topography can occur only in areas that are closely underlain by thick beds of limestone, dolomite, gypsum, salt, or other soluble rock formations. Most of the known areas of karst topography are underlain by limestone or dolomite. Many karst areas occur in the United States and other countries.

In many localities, such as northwestern Illinois and southwestern Missouri, valuable mineral deposits have been described as filling ancient solution channels and cavities. This is indirect proof that karst topography existed in geologic periods other than the present. Unique and direct evidence of this fact was obtained last summer in the vicinity of Kankakee, Illinois, which area is underlain by Niagaran limestone or dolomite at a very shallow depth.

In the quarry of the Lehigh Stone Company, seven miles west and one mile south of Kankakee, are "clay pockets" which on examination proved to be deposits of shale in cavities that are clearly fossil sinks. All of the cavities have the shape of a funnel or a cone with the apex downward. In some of them the walls have a gentle average slope; in others they are precipitate. Again, regardless of the degree of their slope, the walls have a constant and consistent pitch from top to bottom, or they may be made up of alternating projecting and receding layers when the slope is precipitate or of alternating pitches and flats when the average slope is gentle. Except where the wall has collapsed before or during deposition of the shale, it has gen-

<sup>1</sup> Sanders, E. M., "The Cycle of Erosion, in a Karst Region (After Cvijic)", *Geog. Review*, v. 11, No. 4, p. 593-604, 1921.

erally a smooth surface, which is apparently the result of solution. In size the cavities vary from ten to a hundred feet in diameter and from twenty to forty feet deep, and their outlines may be circular, oval, or irregular. They are not arranged regularly relative to one another, but they do show a rude parallelism, controlled probably by joint-planes where solution would be favored. Occasionally two or more cavities may be so close that their upper portions coalesce to form one large pit with several separate downward projections. Along the joint-planes are many smaller vertical tubular solution channels, also filled with shale.

The shale which now fills the cavities is of two general types. The more abundant type is usually light greenish-gray, non-laminated, silty, and contains much crystalline iron-sulfide. It also contains rounded pebbles of limestone and chert. Frequently it is laminated, in which case some of the laminae are either fine, gray sandstone, or thin, black layers of carbonized plant fragments. Rarely the laminae are of variegated colors of purple, blue, green, and gray. This shale has a sub-conchoidal fracture; it weathers rapidly to a non-plastic, non-tenacious silty, gray mud. It fills all the cavities except that portion in each of a few of the larger ones which is occupied by the second type. The second and less common type of shale found in these cavities is black, laminated, carbonaceous, full of carbonized, well-preserved plant fragments and brown spore-cases or seeds, and with an abundance of botryoidal nodules of iron-sulfide that are of all sizes up to about three inches in length. When fresh, this shale has a conchoidal fracture that continues across several laminae. It weathers rapidly on exposure, first dividing into sub-conchoidal, lamellar flakes and then further disintegrating into a black, non-plastic mud. Two or three showers with intermissions of but a few days afford sufficient opportunity to reduce the fresh shale to mud.

Where both types of shale occur in the same "pocket" there is a sharp line of contact between them, and the green shale contains weathered masses of the black, indicating decisively that the green is younger than the

black shale and that there have been at least two separate generations of sinks in this one area. In addition to these two types of shale, there are rare occurrences of a granular, fine or coarse grained, calcareous sandstone that is made up of grains of quartz and of the surrounding limestone. In several cavities there are deranged masses of limestone that are collapsed portions of the walls, and around these masses the shale is practically undisturbed from its horizontal position, showing that the collapse occurred contemporaneous with the deposition of the shale. Similarly, where there are irregularities of the walls or recessive channels, they are filled by shale that is stratigraphically continuous with that in the main pit.

Some idea of the extent of the area which exhibits this phenomenon may be gained from the following facts. The Lehigh Stone Company abandoned an old quarry two miles west of the present one because of the prevalence of "clay pockets". While testing prospective areas on which to locate the present plant, they found similar "clay pockets" abundant over a wide expanse of this region. In an old quarry on the west side of the Kankakee River at Kankakee it is reported that there were found "soapstone pockets," which are doubtless the same as the usual "clay pockets", containing good shale. Several of the farm wells in the intervening territory have been drilled through "mud" for many feet instead of the usual rock, and this fact, considered in the light of the chance location of well sites, indicates that the shale-filled cavities must be numerous, to say the least.

In the eastern part of Bradley, two miles north of Kankakee, are two small circular swamps overgrown with willows, which probably mark the location of large shale-filled sinks like the others. Dr. D. J. Fisher of the University of Chicago reports that in the quarries about Joliet are similar cavities filled with green clay or shale, but there the evidence was insufficient to warrant any positive statement as to their origin or age. Smaller cavities in the Niagaran limestone, filled with Devonian shale or clay, have been reported from a quarry near Elmhurst<sup>1</sup> and from McCook, near Summit<sup>2</sup>.

<sup>1</sup> Weller, Stuart: A Peculiar Devonian Deposit in Northeastern Illinois; *Journal of Geol.*, v. VII, No. 5, 483-488, July-August, 1899.

<sup>2</sup> Personal communication from G. W. Hawley, State Geological Survey.



There is no reason to believe that these cavities are anything but sinks; every geologist who has seen them agrees to that. The only other possible explanation is that they are pot-holes, but their shape disposes of that possibility without argument. Their age can be determined from the deposits that fill them; all geologists who have examined them believe that the green shale or clay and sandstone is Pennsylvanian in age, but the age of the black laminated shale is in doubt. An authority to whom the material was shown has suggested that it may be Devonian; another, that it may be Pennsylvanian; but neither of these has yet had opportunity to study the deposits or the plant fossils sufficiently to make a definite statement. The color of the shale and the occurrence of Devonian shale in cavities in the Niagaran limestone near Chicago tend to strengthen the possibility of Devonian age. If it proves to be Pennsylvanian, the marked difference in character of the two shales and their abrupt contact where they occur together are ample proof of two distinct epochs of deposition.

Two hypotheses may be offered to explain the conditions under which the sinks were filled by shale. One is that after the sinks were formed the outlet at the bottom of each became choked and the pits gradually filled up with material washed into the resulting ponds by surface run-off, in which may have been included much organic debris. The possibility that some of the debris is the residue of plants growing in the sink itself is untenable because the shale is in horizontal layers as is found only in subaqueous deposits, shows no old soil or peat or coal, and contains no plant remnants in place. The other hypothesis is that the area was completely submerged beneath the sea, and there filled with silt, sand, and organic debris. The regularity of the deposits seems to indicate the latter hypothesis the more probable, in which case the abundance of plant remnants indicates that the area was near the shore of that sea.

It is safe to state that at some time after the deposition of the Niagaran limestone or dolomite in the Silurian sea over this area and preceding either the Devonian or the Pennsylvanian period, there was relative emer-

gence of sufficient relief to permit ground water to develop subsurface channels and caverns with surficial sinks. Then there was a complete relative submergence, during which the sinks were filled with black shale, but whether this relative submergence was of Devonian or Pennsylvanian age must yet be determined. A second relative emergence permitted the development of a second generation of sinks, some of which were formed in the rock forming the walls of those developed during the first emergence. A second relative submergence, undoubtedly Pennsylvanian in age, provided opportunity for these sinks in turn to be filled, this time with a green shale.

Since that time there have been relative emergence and subsequent erosion of such overlying formations as may have been deposited, bringing the area to its present altitude. So far as the writer is aware, modern or Pleistocene karst topography nowhere occurs on the Niagaran dolomite, although its altitude would seem to permit such occurrence; in Paleozoic times there were two distinct periods or epochs when a youthful karst topography was well developed in the same formation. Whether this is due to a decrease in the solubility of the Niagaran dolomite or to some other cause is at present a matter of conjecture.