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Merrill A. Stainbrook

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## Additional Notes on the Position of the Independence Shale of the Iowa Devonian

By MERRILL A. STAINBROOK

The Independence shale, the earliest named formation of the Iowa Devonian, was described in 1878 by Samuel Calvin (1). He then, and later (2), stated that it was beneath the Cedar Valley limestone. Several geologists have since suggested that it was the same as the Kenwood shale (5) or a later formation (3, 7, 10) let down into the Cedar Valley. In 1935 Stainbrook (8) corroborated the conclusion of Calvin and in 1945 (9) gave all known evidences in favor of the presence of the shale beneath the Cedar Valley limestone and above the Davenport. The present paper summarizes additional evidences which have since come to light as to the stratigraphic place of the shale.

Several wells in Buchanan county indicate the presence of shale immediately below the Cedar Valley limestone. In Jefferson township (ne.  $\frac{1}{4}$  of Sec. 2, T 87 N, R 10 W) Norton (6) reports a well, 220 feet deep, of which 170 feet are in rock (Cedar Valley), ending in shale. The well is four miles north of the natural exposures of the shale northeast of Brandon. A new city well was drilled in 1949 in Brandon and samples were secured by the writer which were placed in the collection of the Geological Survey. The well reached Cedar Valley limestone at fifteen feet at a horizon well up in the Coralville member. The sample record is as follows:

- 0- 15 ft. Pleistocene
- 15-155 " Limestone, fossiliferous, Cedar Valley
- 155-165 " Shale, Independence

This well is slightly more than a mile west of the exposures on Lime Creek east of town. In 1944 a deep well was drilled near Winthrop (sw.  $\frac{1}{4}$ , se.  $\frac{1}{4}$ , Sec. 14, T 87 N, R 8 W) and the sample study shows:

- 0- 35 ft. Pleistocene
- 35- 90 " Limestone, Cedar Valley
- 90-105 " Shale, Independence
  - 90- 95, shale, dark, with spores; unwashed sample very shaly
  - 95-100, shale and limestone, small calcite rhombs and small doubly pyramided quartz crystals; pyrite; silty
  - 100-105, washed sample mostly shale, spores common.
- 105-120 " Limestone, Davenport
- 120-130 " Dolomite, Spring Grove
- 130-135 " Kenwood
- 135-145 " Silurian

The shale contains small quartz crystals and calcite rhombs similar to those obtained in washing of shale from natural exposures. The spores are flat and discoidal resembling those seen in shale below Cedar Valley in a well near Van Horne and in natural outcrops. In Washington township northeast of Independence (ne.  $\frac{1}{4}$  Sec. 36) a well 136 feet deep, according to Norton (5), reached rock (Cedar Valley) at 20 feet and penetrates shale for forty feet.

- 0- 20 ft. Pleistocene
- 20- 96 " Limestone, Cedar Valley
- 96-136 " Shale, Independence

This well is in the section immediately east of the one in which the original discovery of the shale was made in a pit sunk in search of coal. It is also within a halfmile of the place where fossiliferous shale may be seen in place beneath Cedar Valley limestone.

The George Dege well in Quasqueton (se.  $\frac{1}{4}$  Sec. 34, T 88 N, R 8 W) has shale as indicated by a study of the well samples.

- 0- 5 ft. No sample
- 5- 45 " Limestone, Cedar Valley
- 45- 65 " Shale, Independence
- 45- 55 ft. shale with small quartz crystals, etc.
- 55- 60 " shale with small bipyramidal quartz crystals, small scalenohedrons of calcite, pyrite
- 60- 65 " shale as above
- 65- 80 " Spring Grove

Another well, in Westburg township (se. ne. Sec. 27, T 88 N, R 10 W), shows presence of shale and is about two miles northwest of the well reported by Norton as noted above.

- 0- 60 ft. Pleistocene
- 60-155 " Limestone, Cedar Valley
- 155-160 " Shale, Independence
- 160-170 " Limestone, Davenport
- 170-180 " No sample
- 180- " Silurian

In Linn County several recent wells and reopened quarries yield further evidence of the presence of shale beneath the Cedar Valley. Near Palo on the A. P. Rankin farm a well drilled by Hoeg & Ames was logged as follows:

- 0- 10 ft. Yellow clay, Pleistocene
- 10- 36 " Limestone, Cedar Valley
- 36- 70 " Shale, Independence
- 70-130 " Limestone, Wapsipinicon

This well is in the same section (sw.  $\frac{1}{4}$ , sw.  $\frac{1}{4}$ , Sec. 17, T 84 N, R 8 W) and about a quarter-mile northwest of the locality on Bear

Creek where fossiliferous shale occurs below Cedar Valley and has been bored to a depth of sixteen feet as reported by Dille. South of Marion a well was put down, slightly north of the north valley wall of Indian Creek on the Herbert Stamatz farm (nw.  $\frac{1}{4}$ , sw.  $\frac{1}{4}$ , Sec. 17, T 83 N, R 6 W). A study of the drilling samples shows:

- 0-100 ft. Pleistocene
- 100-130 " Limestone, Cedar Valley
- 130-204 " Shale, Independence
  - 130-140, shale, dark gray, much fine sand
  - 140-150, bluish shale, sandy; small bipyramidal quartz crystals; fossils as crinoid columnals, ostracode, *Astraeospongia* spicules.
  - 150-160, blue shale, yellow dolomite; fossils as *Tentaculites*.
  - 160-170, blue gray shale: fossils such as crinoid columnals and brachiopod fragments.
  - 170-180, dark blue shale; fossils abundant as brachiopod fragments, *Aulacella infera* Calvin, coral, *Astraeospongia* spicules, crinoid columnals and many bryozoans.
  - 180-190, as above
  - 190-204, dark gray shale; fossils as brachiopod fragments, a valve of *Douvillina*, crinoid columnals.

In the road to the west of the farm Cedar Valley limestone blocks appeared in the roadside ditch well up on the hillside, blocks of Davenport low down in the ditch and Otis in the creek above the bridge. Near Center Point the C. D. Mounce well (nw. c Sec. 23, T 85 N, R 8 W) also shows shale below the Cedar Valley. Although the well was briefly mentioned previously (9), the record is repeated here after further study of the drilling samples. The strata recorded are:

- 0- 13 ft. Pleistocene
- 13- 90 " Limestone, Cedar Valley
- 90-144 " Shale, blue, sandy; containing pyrite, crinoid columnals, echinoid spine and small bipyramidal quartz crystals, Independence.
- 144-155 " Limestone, Davenport
- 160-180 " Dolomite, Spring Grove
- 180-190 " Spring Grove and Kenwood
- 190-195 " Otis?
- 195-205 " Silurian

A more recent well is that of the Walker Locker Plant at Walker. The drilling samples show:

- 0-105 ft. Pleistocene
- 105-125 " Limestone, Cedar Valley
- 125-150 " Shale, Independence: fossils not uncommon and typical, among those identified are: two conodont jaws, *Aulacella*

*infera* Calvin, *Tentaculites* sp., *Douwillinaria variabilis* (Calvin), *Atrypa devoniana* Webster, spores

A mile or so south of Walker the basal beds of the Cedar Valley outcrop in the bank of small stream. A well was drilled in the fall of 1949 at Midway, immediately west of Highway 150 northeast of Toddville (ne.  $\frac{1}{4}$ , ne.  $\frac{1}{4}$ , Sec. 7, T 84 N, R 7 W.). Samples were secured by the writer for the Geological Survey. The samples record the following strata:

- 0- 22 ft. Pleistocene
- 22-112 " Limestone, Cedar Valley
- 112-122 " Shale, Independence

The well is situated on high ground west of the valley of East Otter creek. Along the road eastward basal zones of the Cedar Valley outcrop nearly continuously and in the beds of the creek as well. About a mile east of the well Independence shale may be seen just above creek level beneath Cedar Valley limestone and above Davenport.

Two recently reworked quarries in the basal Cedar Valley beds northwest of Cedar Rapids throw further light on the occurrence of the Independence shale. In the first (ne.  $\frac{1}{4}$ , se.  $\frac{1}{4}$ , Sec. 32, T 83 N, R 8 W) a considerable area of limestone several feet in thickness was left in the floor of the quarry to avoid bogging down the machinery in the sticky blue shale below. In the north wall of the quarry an upwardly bulging mass of shale appeared from which a small channel led up to a spreading smaller mass in the top of the quarry. The shale carried typical fossils of the Independence and the upper body had considerable numbers of blocks of limestone incorporated therein while the basal mass of shale was apparently devoid of them. Upward movement of the shale rather than downward movement seemed therefor to be indicated. In the second quarry northeast of the first in the center of Section 23 (T 83 N, R 8 W) the Independence shale was not present but had apparently been incorporated into the well developed basal breccia of the Cedar Valley, the matrix of which was very shaly. This occurrence confirms the previous observation that where the basal Cedar Valley breccia is thick, the Independence shale is usually absent.

The recently reopened quarry a mile or so north of Ely (sw.  $\frac{1}{4}$ , nw.  $\frac{1}{4}$ , Sec. 8, T 82 N, R 6 W), just east of the road, yields additional evidence of the presence of shale below Cedar Valley. At the north end the quarry is bottomed on the gently domed Davenport limestone. Above the latter are about six feet of shale and limy marl, distinctly set off from the Davenport below and the Cedar

Valley above. The shale here has not afforded any fossils. The Cedar Valley limestone is distinctly brecciated and carries numerous small blocks of limestone resembling that of the Davenport. Similar breccia is observable at Independence, Troy Mills and Quasqueton. Cedar Valley fossils are present in the matrix of the breccia.

Another quarry recently (1949) is at Fairfax about a block north of the Chicago and Northwestern depot. Shale was reached here years ago in the floor of the quarry and below but was soon covered by water when the quarry was in disuse. At least six feet occurs in one place below Cedar Valley breccia and was found to be fossiliferous when first discovered. The shale is dark and silty above but typically blue-gray at the base of the quarry. The shale appears to be in place below Cedar Valley limestone.

Another illuminating exposure of the shale was made in the immediate vicinity of the hamlet of Alice (ne.  $\frac{1}{4}$ , nw.  $\frac{1}{4}$ , Sec. 8, T 85 N, R 7 W). An old quarry was recently reopened and extensively excavated for road metal. In order to drain the quarry pit a ditch was dug to the west so that the water could run into the adjacent brook. This ditch penetrated the Independence shale to a depth of several feet for two rods or so. The shale is typically blue-gray, plastic, and carries the typical commoner fossils of the terrane. The appearance of the shale at the level and place one would expect it to be if it were beneath the Cedar Valley limestone, is considered to be highly significant.

In summary the evidence afforded by these wells and quarries appears to the writer to give powerful support to the conclusions advanced in his previous paper (9) on the stratigraphy of the Independence shale and to the earlier observations of Calvin (2). The records of the occurrence of fossiliferous shale beneath Cedar Valley limestone in numerous wells, quarries and natural exposures are such as would appear to negate any conclusion that the shale was let down from a superior formation. It would seem to be the height of coincidence that the shale would come to rest at the base of the Cedar Valley in so many places and nowhere below it.

The importance of the position of the Independence shale lies in the presence therein of a fauna of lower Upper Devonian age, a fauna that is, so far as now known, in America the most similar to that in the basal Frasnian beds of Belgium and France. It would seem to follow necessarily that the superjacent Cedar Valley should be regarded as Upper Devonian also. The fauna of the Cedar Valley limestone with few exceptions is not inconsistent with this placement. The matter may also have some importance in petro-

leum geology as strata of apparently like age are oil bearing in Alberta. In eastern United States also the Upper Devonian is a notable source of oil.

Lastly the anomalous occurrences of the Independence shale adjacent to various zones of the Cedar Valley in situations akin to faulting or upward thrusting are readily explained through information gained in a study of numerous well logs now available in the files of the Geological Survey. Since the explanation will be the subject of a future paper it will not be elaborated here.

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