Technical Papers

Early Devonian Deformation on Arbuckle Creek, Marion County, Kentucky

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Significant faulting and folding of Richmond (Upper Ordovician) limestones and shales occur on the headwaters of Arbuckle Creek in central-southern Marion County at a point 7.3 airline miles southeast of Lebanon, Ky. The area of typical exposure is located about half a mile north of Muldraugh's Hill (1045′) and the Taylor County line in the central part of the commonwealth. Maximum local topographic relief is about 385′. This structural disturbance is unconformably overlain by beds of sandstone, sandstone conglomerate, and limestone of Onondaga and Hamilton (Middle Devonian) age, which exhibit neither the faulting nor the folding of the underlying Richmond sediments. Because of the comparative rarity of clear and well-defined mid-Paleozoic deformation in the eastern half of the Mississippi Valley, it has seemed important to outline the principal features of this accessible and most interesting occurrence.

The faults in this area on Upper Arbuckle Creek (660′–685′) were discovered by the writer on March 20, 1952, and have since been carefully studied and mapped. Undescribed previously in the literature, they are of the normal type, nearly parallel in extent and *en echelon* in pattern. They exhibit angles of

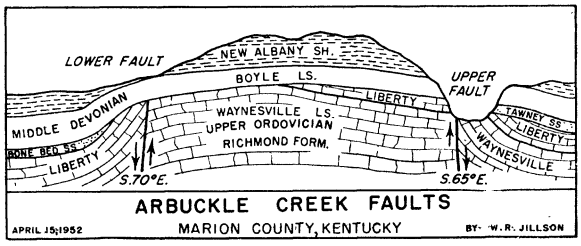

FIG. 1.

strike of S 70° E in the north break, and S 65° E in the south. Between these faults (Fig. 1) there exists a horst, or competent, rectilinear earth block, the width of which ranges from about 350′ to 400′. As exposed, this horst is made up of the lower part of the Liberty (uppermost division of the Richmond in this area) and the underlying Waynesville. The Liberty is identified by a long list of characteristic invertebrate fossils, chiefly brachiopods and bryozoans. The Waynesville, although carefully searched, appears to be essentially nonfossiliferous in this area.

The northern fault on Arbuckle Creek exhibits a downthrow of about 40′ or 50′ on the northeast side, with upturned limestone beds of the Liberty (including the *Columnaria alveolata* reef) dipping N 20° E at angles of 30°–45° downstream. These deformed beds offset the stratigraphically lower, grayish-green, compact, thin limy shales of the Waynesville, which dip 2°–3° N 30° E in the channel of the creek. The drag zone of actual movement is covered by small limestone and chert rubble in the bed of the creek. The abutting property is owned by Sam B. Luckett on the west and by John Spalding on the east.

The southern fault, exposed about 1500′ farther up the left fork of Arbuckle Creek, facing the property of Clem Tungate on the southwest, is of opposite pattern, but otherwise similar. Downthrow is on the southwest side, and the displacement is probably not more than 15′ or 20′. Here nicely exposed, almost longitudinally with the creek, upturned Waynesville limy shales on the downthrow side dip S 25° W from 30° to 50°, and are overlain at lesser angles by a thin, lower portion of the Liberty, which also contains the *Columnaria alveolata* horizon. This southern fault can also be plainly seen just below and on the Kirtland Branch of the right fork of Arbuckle Creek, ¾–1 mile to the northwest. The full extent of these faults is unknown, as they pass more distantly to the northwest and the southeast beneath undisturbed Middle Devonian sediments and are seen no more.

Both the northeast and the southwest downthrow blocks of these Arbuckle Creek faults are overlain by a tawny-colored, conglomeratic sandstone, which here exhibits a large amount of broken fishbones, plates, and very small teeth, together with numerous black to rust-colored phosphatic and ferrugenous nodules, ranging usually from 1 to 3 cm in diameter. Some, if not all, of these nodules may have originally been coprolites. Less commonly, an elongate, gray (apparently Richmond) limestone shore pebble, ranging from 6 to 9 cm in length and 3 to 6.5 cm in width, appears in this unusual clastic sediment, the dark-yellow color of which is, in many specimens, heightened into a distinct reddish brown by the rapid increase of fine bony material. This sandstone, which is usually tough and hard, is, however, frequently soft and friable at points close to the outcrop. It is composed in large part of clear, granular silica, generally of large grain-size, with a small but distinctly recognizable lime cement, which is unevenly distributed and may have been deposited by percolating ground or marine water during the late Paleozoic. An exceptionally interesting horizon, it is regarded as sufficiently distinctive and unusual to deserve specific stratigraphic recognition, and accordingly is here named the Bone Bed Sandstone. Close examination has revealed in this clastic horizon three fragmentary brachiopods, of as yet undetermined species but decidely Middle Devonian in appearance.

A very remarkable sedimentary unit, of probably

rather limited extent, the Bone Bed Sandstone has a thickness ranging from 1′ to 20′ in this particular area on Arbuckle Creek, 2′–4′ being common in close proximity to the faults, against which it thins and disappears. In the local stratigraphic section it is sometimes replaced by 1 or 2 in. of a tough, dark, sandy lime, which appears to be what A. F. Foerste, in 1906, working 30–50 miles away on the east side of the Cincinnati Arch, styled "the Kiddville layer" of the Middle Devonian lime. In any event, throughout this disturbed area on upper Arbuckle Creek, some 8′–20′ of the Boyle limestone (Middle Devonian), which overlies the Bone Bed Sandstone, the thin superjacent Duffin lime, and the succeeding New Albany (Upper Devonian) black shale, here exhibiting eroded thicknesses ranging from 1′ to 30′, unconformably override the faults and folds in the Upper Ordovician sediments (no Silurian and no Lower Devonian being present) and clearly define this structural disturbance as confined to the latter part of the early Devonian. The clarity of the angular unconformity, the faulted structure, and its unquestionable geologic dating as late early Devonian make this disturbance on Upper Arbuckle Creek (right and left forks) an ideal locality for field study.

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Isolation in Suckling Mice of a Virus from C_3H Mice Harboring Bittner Milk Agent[1]

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A virus, provisionally referred to as the K-virus, has been isolated by intracerebral inoculation of suckling mice from female C_3H mice carrying the Bittner milk agent. So far it has not been determined whether this virus is related to the tumor-inducing agent. It is felt, however, that such observations of the K-virus as have been made are of general interest and warrant publication. All mice used as a source of tissue for isolation, or attempted isolation, of virus were kindly provided by Howard B. Andervont.

Isolation was first accomplished in a litter of one-day-old regular Swiss mice inoculated intracerebrally with an extract of liver, spleen, and mammary adenocarcinoma of an adult C_3H mouse. Twelve days after inoculation, one mouse developed labored respiration and was found to have marked pulmonary consolidation. An extract of the lungs was passed intracerebrally to a second litter of Swiss mice. Succeeding passages were all brain-to-brain transfers. Virulence increased so that by the fifth passage nearly all mice inoculated became ill, usually in 8–10 days, with death following within 24 hr. Moribund mice were well nourished and had stomachs full of milk. Although all mice becoming ill on intracerebral inoculation developed labored respiration, only about 50% had gross evidence of pulmonary consolidation. So far, 13 consecutive passages have been made in suckling mice. Repeated cultures of brains harvested gave no evidence that bacterial contamination was a factor. Many thousands of suckling mice of the same stock have been inoculated intracerebrally in the course of experiments with other viruses without evidence of subsequent pulmonary consolidation, suggesting that the virus was contained in the original inoculum.

The K-virus will pass through a Selas .03 bacteria-tight filter, is resistant to freezing and thawing, will withstand 16 days' exposure to room temperature, and is unaffected by penicillin and streptomycin. By intracerebral inoculation, the virus has a titer of 10^{-5} and a somewhat lower titer by the intraperitoneal route. Subcutaneous inoculation has succeeded only with low dilutions. Pulmonary consolidation, occasionally with pleural fluid, has been produced by all routes. Intranasal inoculation has not shortened the incubation period. As mice becoming ill following inoculation with K-virus show no clinical or pathologic signs of CNS involvement, it is possible that success of brain-to-brain transfers rests primarily on blood contained in organ extracts. Continuing studies indicate that heart blood, when injected alone, is infectious. Young sucklings of all strains of mice so far tried have been found susceptible, including C_3H, C57 Black, A-strain, C-strain, and regular Swiss. Older mice, regardless of strain or route of inoculation, have been found resistant to obvious pathogenic effects of K-virus. Likewise, attempts to infect embryonated eggs, suckling rabbits, either suckling or adult hamsters, adult guinea pigs, meadow mice (*Microtus*), or deer mice (*Peromyscus*) have been unsuccessful.

A second probable isolation was made from the mammary glands of 2 lactating C_3H mice harvested 2 weeks after birth of the young. On first passage in C-strain mice, inoculated both intracerebrally and intraperitoneally at 2 days of age, 2 mice developed labored respiration after an incubation period of 9 days, one having characteristic pulmonary consolidation. Continued passages will be needed to demonstrate more definitely the identity of this second isolation with the original K-virus. Isolation of K-virus from mice known to carry the Bittner agent has generally proved difficult, as many attempts have been unsuccessful. Repeated attempts, likewise without success, have been made to isolate K-virus from strains of mice known to be free of the agent, using extracts of liver, spleen, and mammary tissue.

There has been little indication of relationship between the K-virus and other known mouse viruses, failure to infect older suckling or adult mice being a striking peculiarity. Affected mice show none of the neurological or muscular signs characterizing illness that is due to Coxsackie or Newcastle viruses. Furthermore, NDV immune serum does not neutralize the

[1] A preliminary report.