NOTES AND NEWS

SULFIDE REPLACEMENTS OF A TRIGONOCARPUS FOSSIL FERN FRUIT

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An uncommon replacement, practically complete, of fossil fern fruit by galena, sphalerite, and pyrite, with dickite and kaolinite in the cracks, is here described. The occurrence of the Trigonocarpus fossils from another of the few localities in Missouri is likewise placed on record.[1]

The fossil fruits, which have been popularly called "petrified pecan nuts" because of their superficial resemblance to modern pecans, were given to the writer about 10 years ago by Mr. James Myers, of near Eldon, Missouri. They were collected from the old McClure's coal bank,[2] S.E. $\frac{1}{4}$, Sec. 12, T. 41 N., R. 16 W. which was temporarily reopened during the depression following World War I. Nothing is known of their occurrence except that they were recovered during the mining operation.

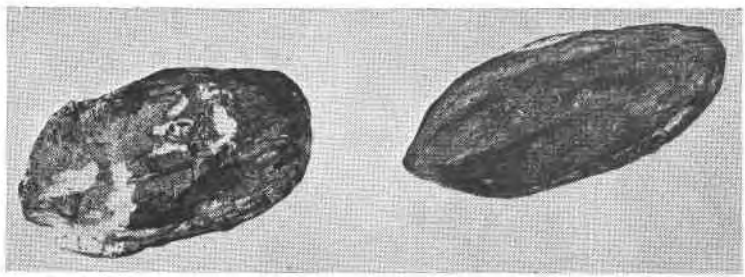

FIG. 1. Trigonocarpus fern fruit replaced by sulfides, with dickite and kaolinite along the cracks. Approximately natural size.

Two of the fruits are shown in Fig. 1. They are 3.5 to 4 cm. long, about 2 cm. wide, and about 1.5 cm. thick, but their slightly flattened shape may be due to squeezing after deposition.

Three nearly equal divisions or partitions which run lengthwise in the fruit are joined along depressed contacts which end in little ridges at the fruit ends. Faint longitudinal lines run along the shells parallel to the partitions.

[1] Previously mentioned in, A preliminary catalogue of the fossils occurring in Missouri, G. Hambach: *Bull.* **1**, *Missouri Geological Survey*, 85 (1890).

Fossil flora of the lower coal measures of Missouri, David White: *U. S. Geological Survey*, Monograph No. **37**, 280 (1899).

[2] Geology of Miller County, Sydney H. Ball and A. F. Smith: *Missouri Bureau of Geology and Mines*, vol. **1**, 2nd sec., 153 (1903).

Little or no carbon, or other organic material remains. Perhaps as much as 95 per cent of the fruit specimen has been replaced by galena which shows its characteristic luster and cleavage in the one specimen that is broken at the end. Covering the galena, apparently as a more or less continuous shell or peeling about $\frac{1}{2}$ mm. in thickness, lies resinous sphalerite. This is coated irregularly with a very thin film of brassy pyrite.[3]

Cracks which were opened along divisions in the fruit, or along cleavages in the galena are filled with glistening white clay flakes. The clay flakes have indices of refraction falling within the kaolin group, and most of them, but not all, are euhedral and hexagonal in outline, which suggests they are dickite rather than kaolinite. Some books showed across the cleavages a biaxial positive interference figure which is also characteristic of dickite, but none was found which showed an extinction angle more than 5°—negative evidence for dickite. An *x*-ray diffraction pattern of the clay was generously run by Professor O. R. Grawe[3] who reported:

> In some respects our diffraction pattern closely resembles that of dickite, in others that of kaolinite. The results would suggest that both minerals are present.

Subsequently, an electron diffraction photograph made of the Trigonocarpus clay was compared with those of known dickite and kaolinite and found to substantiate Grawe's report that a mixture of dickite and kaolinite was present. The association of dickite with sulfides is interesting in view of other Missouri occurrences.

Tarr[4] found dickite in southeastern Missouri associated with galena in the Ordovician Bonneterre dolomite, and Tarr and Keller[5] found dickite associated with chalcopyrite, galena, pyrite, and millerite in chert in Mississippian Burlington limestone in Missouri. Allen[6] reported dickite in a chert geode from St. Louis County. Grohskopf[7] and Hundhausen found dickite in nine Cambrian and Ordovician formations in Perry County, where it (dickite) was intergrown with pyrite, and associated with sphalerite and galena.

Tarr interpreted the occurrence of dickite as indicative of hydrothermal solutions which brought in the sulfides, and Allen accepted a hydro-

[3] Determination by *x*-ray diffraction, O. R. Grawe: personal communication (December, 1946).

[4] Origin of the southeastern Missouri lead deposits, W. A. Tarr: *Econ. Geol.*, **7**, 749 (1936).

[5] Dickite in Missouri: *Am. Mineral.*, **21**, 109–114 (1936).

[6] Dickite from St. Louis County, Missouri, Victor T. Allen: *Am. Mineral.*, **21**, 457–459 (1936).

[7] Occurrence of dickite and fluorite in the Cambrian and Ordovician of Perry County, Missouri, J. G. Grohskopf and Mary Hundhausen: Appendix III, 59th Annual Report, *Missouri Geological Survey and Water Resources*, 3–13 (1937).

thermal origin for it, thus affording "evidence . . . that hydrothermal solutions reached east central Missouri during post-Mississippian time." Because the Trigonocarpus fosils are Pennsylvanian in age, the sulfides and dickite of Miller County must be Pennsylvanian or later in age, which is in accord with Allen's dating. The rather widespread association of dickite and sulfides across Missouri implies some interesting academic and possibly economic geological possibilities.

Kaolinite which resembles superficially the clean, white Trigonocarpus clay has been reported[8] as a deposit from solution in several Missouri localities, but the temperature of its origin is not certain. The writer would like to raise this question about a hydrothermal interpretation of the origin of dickite occurring in otherwise unaltered sediments: is it reasonable that sedimentary rocks which are fairly deeply buried may be heated high enough by conduction in establishing a normal geothermal gradient so that dickite is deposited in them instead of, or along with kaolinite? Water in them might be warm (hydrothermal?) over a wide area without necessarily emanating from a magma which otherwise would have to be postulated as being disturbingly widespread.

The writer is indebted to Professor Ralph W. Chaney for identification of the fossil fern fruit and comments on it. He wrote (July 16, 1945):

> The specimens represent fruits of the Pennsylvanian genus Trigonocarpus. This is a seed fern whose stem equivalent is Medullosa and whose equivalent foliage genus is Alethopteris. These fruits are of fairly common occurrence in Pennsylvanian rocks throughout the northern hemisphere. I have never before seen any partly replaced with metals.

Only one other fossil was reported from the McClure coal bank: (zinc) "blende was found, upon the exterior of which is a perfect imprint of a fern."[9]

[8] Some occurrences of kaolinite deposited from solution, W. A. Tarr and W. D. Keller: *Am. Mineral.*, **22**, 933 (1937).

[9] Ref. No. 2, p. 180.