[AMERICAN JOURNAL OF SCIENCE, VOL. 254, APRIL 1956, P. 257-259]

X-RAY DIFFRACTION STUDY OF INORGANIC STRUCTURAL UNITS IN FOSSIL WOOD

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ABSTRACT. About nine minerals have been identified by the X-ray diffraction method in a silicified wood belonging to an undetermined species of *Dadoxylon*. Of these, seven are reported for the first time as occurring in petrifaction. Low-quartz is by far the dominant mineral species present in the fossil wood. The quantitative estimation of the different minerals present in the material, now being done, is likely to indicate whether or not carnegieite and amesite and a few others are also petrifying minerals.

INTRODUCTION

The structural units of well preserved petrifactions are the extremely small grains of different species of minerals that fill up the cell cavities and variously impregnate, and in extreme cases, replace the remnants of the original cell wall. Thus the anatomical organization characteristic of a species is preserved. Sometimes the organic structure has been variously disturbed and destroyed preceding and during fossilization, as for example by unfavorably large crystals of the petrifying mineral. Probably the different species of minerals involved in the petrifaction, however small the grains may be, also preserved plant tissues differently. Thus Andrews and Mamay (1952, p. 67) found that preservation is generally poor in iron sulphides. The identification of petrifying minerals in variably preserved materials will, therefore, gradually make it possible to determine the relative value of different mineral species in the preservation of ancient plant life. Knowledge of the petrifying minerals is necessary for studying the structure of variably mineralized cell walls in fossil plants and in understanding some of the unknown events associated with the fossilization process. Some of these will de described elsewhere.

The mineral sources of petrified wood and of our coal seams may be the same since their woody mother substances might have drifted in similar lakes or rivers under similar conditions before they were deposited. In the Northern Hemisphere, where the coal balls containing the petrifactions occur in the coal seams proper, the mineral sources are more likely to be the same. The identification of minerals in petrifactions is likely therefore to offer some clues as to the assemblage of minerals present in coal. In the present work, X-ray diffraction method has been used to identify the minerals in petrifactions from the Lower Gondwana strata, where the particle size of the minerals, both in the coal and in the petrifaction, is usually so small that the grains cannot be identified by the petrological microscope.

MATERIAL

The material consists of a piece of silicified wood of *Dadoxylon* sp. collected from Mahuda in Bihar, in the Upper Permian of India.

EXPERIMENTAL PROCEDURE AND RESULTS

The untreated sample was powdered in an agate mortar and made into a thick paste with collodion dissolved in ether. A cylindrical fiber less than 0.5 mm in diameter was made, which hardened rapidly as the ether evapor-

ated. The fiber was mounted on the axis of a cylindrical camera (10 cm diameter) and was centered with the help of a goniometer head. The X-rays (CuKα = 1.54 A.U.) from a Hadding tube running at about 60 k.v. and 8 to 10 ma. were used. The time of exposure was three hours.

TABLE 1

Results of the X-ray Diffraction Study of *Dadoxylon* sp.

Serial no.	θ	d Å	Intensity	Serial no.	θ	d Å	Intensity
1	4°58′	8.95	M.S.	22	27°57′	1.64	V.V.W.
	7°27′	5.92		23	29°20′	1.57	V.S.
2	9°10′	4.81	V.W.	24	31°8′	1.49	W
3	9°47′	4.53	M.W.	25	32°8′	1.45	V.W.
4	10°15′	4.32	S	26	33°13′	1.40	V.S.
5	11°29′	3.87	M.S.	27	34°37′	1.36	V.W.
6	11°57′	3.72	S	28	35°0′	1.34	V.W.
7	12°35′	3.53	M.S.	29	35°43′	1.32	W
8	13°2′	3.42	V.V.S.	30	36°57′	1.28	W
9	15°40′	2.85	V.W.	31	37°53′	1.25	V.W.
10	16°12′	2.75	W	32	38°58′	1.22	M.S.
11	17°23′	2.57	W	33	39°35′	1.20	M.S.
12	17°51′	2.52	M.W.	34	40°50′	1.18	W
13	18°43′	2.40	V.W.				
14	19°25′	2.32	M.S.				
15	19°52′	2.26	W				
16	20°48′	2.17	M.S.				
17	22°3′	2.05	W				
18	22°22′	2.02	W				
19	24°32′	1.85	V.S.				
20	26°14′	1.74	W				
21	26°47′	1.71	S				

V.V.S.—Very Very Strong
S.—Strong
M.S.—Medium Strong
M.W.—Medium Weak
W.—Weak
V.W.—Very Weak
V.V.W.—Very Very Weak

The minerals were identified following the method developed by Mitra (1950, p. 133-34; 1954a, p. 318-322); the spacings of the characteristic lines of different minerals in a standard chart prepared for this purpose were compared with those of the wood sample under examination.

Some of the weak lines of the less abundant constituent minerals were missing in the diffraction photograph. A rigidly consistent standard has been followed in determining which lines should be omitted. If for a certain mineral a line of particular intensity is missing from the pattern, then no other line of equal or less intensity has been admitted as belonging to this mineral. Where two or more lines overlap, the sum of the intensities of the lines of the constituent minerals has been found to agree with the intensity of the resultant line in the powder pattern of the substance to be identified. Following these rules, in spite of the complexity of the diffraction pattern, nine minerals could be identified in the *Dadoxylon* sp.

The minerals identified are low-quartz, magnetite, pyrite, carnegieite, serpentine, amesite, willemite, dickite, and brucite. From the X-ray diffraction data it is apparent that quartz forms the main bulk of the material. Carnegieite and amesite are also quite abundant, however. Magnetite, pyrite, dickite, and brucite seem to be present in small quantities. A rather large number of lines of serpentine and willemite seem to agree with the diffraction pattern of the fossil, but in the absence of quantitative data their identification cannot be considered certain. Quantitative estimation of the minerals by the X-ray diffraction method developed by Mitra (1954b, p. 337-338) is now in progress. It is difficult to determine at present how many of these mineral species are actually responsible for causing the petrifaction of the wood under investigation. Excepting quartz and pyrite, these minerals were apparently not known before in petrifactions, judging from the list prepared by St. John (1927, p. 729).

The orientation of the mineral grains in this and similar petrified materials is now being studied by the X-ray diffraction method to ascertain the nature of growth fabrics in petrified wood, and to determine whether the anisotropy in the original wood may be reproduced in the fossils.

ACKNOWLEDGMENTS

The authors are grateful to Professor K. Banerjee of the Indian Association for the Cultivation of Science, Calcutta (now Professor and Head of the Department of Physics, Allahabad University) for taking keen interest in this work and allowing us laboratory facilities, and to Professor Chester A. Arnold of the University of Michigan, Ann Arbor, Michigan, U.S.A., for some valuable information. Thanks are also due to Dr. S. N. Sen of the Department of Geology, Calcutta University, for confirming our identification as far as possible under the petrological microscope.

REFERENCES

Andrews, H. N., and Mamay, S. H., 1952, A brief conspectus of American coal ball studies: The Palaeobotanist, v. 1, p. 66-71.

Mitra, G. B., 1950, Examination of Indian coals by the X-ray diffraction method: Jour. Sci. Indus. Research, Delhi, v. 9, sec. B, p. 133-135.

————, 1954a, Identification of inorganic impurities in coal by the X-ray diffraction method: Fuel, v. 33, p. 316-329.

————, 1954b, Quantitative Analyse der in indischer Kohle enthaltenen Mineralien mit Hilfe der Röntgenstrahlbeugung: Brennstoff-Chemie, no. 21/22, Band 35, p. 337-338.

St. John, Ruth N., 1927, Replacement vs. impregnation in petrified wood: Econ. Geology, v. 22, p. 729-739.

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