ARTICULO

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OCCURRENCE OF POLLEN AND SPORES IN THE RORAIMA FORMATION OF VENEZUELA AND BRITISH GUIANA

(OCURRENCIA DE POLEN Y ESPORAS EN LA FORMACION RORAIMA DE VENEZUELA Y GUAYANA BRITANICA)

by R. M. Stainforth

The discovery of pollen and spores in beds considered Precambrian (Proterozoic) has received brief notice in geological journals and the press[1-3]. Individual authors will doubtless publish detailed stratigraphic and palynologic accounts of the occurrence in due course. Meanwhile it is considered desirable to give an outline of the facts of the case before distorted interpretations develop from inadequate data. The following summary statement has been prepared jointly by several members of the Asociación Venezolana de Geología, Minería y Petróleo. A single author is nominated to simplify bibliographic references.

Late in 1963 G.C.K. Dunsterville made an expedition to collect orchids around Cerro Venamo, at the westernmost point on the frontier between Venezuela and British Guiana (where this mountain is known as Wenamu Head). He noted some shale-like beds at the base of a towering cliff of Roraima sandstone and collected samples for their possible paleontological interest.

G. Fournier, palynologist of the Mene Grande Oil Company, processed the samples and recovered well-preserved pollen and spores. Subsequently, L. Nijssen and J. A. Sulek, palynologists of Compañía Shell de Venezuela and Creole Petroleum Corporation, respectively, processed other pieces and recovered identical plant microfossils.

This discovery of pollen and spores in a formation of supposed Precambrian age was so remarkable that a reconnaissance expedition of qualified geologists was organized to verify the facts of the case. During April, 1964, with the assistance of personnel and vehicles of the Ministerio de Minas e Hidrocarburos, the locality was visited by a party which included N. Benain, P. J. Bermúdez, A. Espejo, G. Fournier, A. Menéndez, J. A. Sulek and F. Wright. They confirmed the salient facts as recorded by Dunsterville. The shale-like beds, being less competent, had eroded away below the massive Roraima sandstone, leaving an undercut extending 10-12 ft. inwards at the base of the cliff. The original samples were loose, weathered fragments from the talus slope below. New samples of unweathered rock were collected from the face of the undercut.

On their return to Caracas, the three palynologists made independent investigations of the new samples. Utmost care was taken to avoid any possibility of superficial contamination. The rock cleaves along finely laminated bedding planes which are coated with limonite. Every effort was made to avoid these planes and

some of the pieces processed were the central nubs left after chipping away the external parts of large blocks of the rock, which was dense enough to sound when struck with a hammer. Nevertheless, microfossils of the same type as before were recovered.

Dr. P.H.A. Martin-Kaye, director of the British Guiana Geological Survey, was told of these discoveries in view of his group's sponsorship of radiometric dating of the Roraima Formation. He collaborated by sending samples of beds described as 'hornfelsized sediments' from a seemingly correlative level near Paruima on the Kamarang River, some 25 miles east of the original locality. As before, independent investigations were made of this material, and the same flora was recorded. Still more samples were submitted by the Survey, this time from the Kopinang area, about 110 miles south-east of Paruima. In this case, however, only indeterminate plant microfossils were obtained, not the distinctive suite recorded at Cerro Venamo and Paruima.

It needs to be stated that petrological investigation of the rocks which yielded pollen and spores showed them to be highly metamorphosed, even though in hand specimens they somewhat resembled indurated shales (Fig. 1). J. M. Bowen (Cía. Shell de Venezuela) described the samples from both Cerro Venamo and Paruima as true hornfelses in the cordierite-andalusite range, based on thin-section investigations (Fig. 2). Prof. H.H. Hess (Princeton University) confirmed this on the basis of X-ray diffraction investigations, and described the rock as a fairly typical hornfels, largely muscovite plus a little quartz, clay minerals apparently absent, and no chlorite noted. The samples from Paruima were rather more highly metamorphosed, as shown by the presence of biotite.

Fig. 3 shows a highly generalized regional cross-section based on the current geological map of British Guiana. The remarkably horizontal attitude of the Roraima Formation and the persistence of dolerite sills[4] over vast distances appear to justify the long-range correlations indicated. Relative positions are shown of the polliniferous samples and of samples dated Precambrian by radiometric techniques.

The palynological assemblage has not yet been matched conclusively against any known suite, a fact which is not surprising in view of the distance from control sections of known age and the highly endemic character of the flora of to-day, and probably the geological past, on the isolated Roraima Plateau. G. Fournier, by utilizing the herbarium of J. Steyermark, was able to compare the recent pollen of the area with the assemblage in the rocks, and has stated that they are not the same. The first opinion of Fournier was that the pollen showed Cretaceous affinities, but closer study has led to preference for a Tertiary age. L. Nijssen regards the best-assemblage, from a Paruima sample, as not older than Eocene and quite possibly post-Eocene. J.W. Funkhouser (Bogotá) considers the pollen indigenous to the samples he processed but claims an age no older than Miocene, and probably younger; he notes similarities to the flora of the Mesa Formation (Pliocene-?Pleistocene) of Colombia, presence of pollen of the Compositae, and an uncompressed preservation highly unusual except in young sediments. T. van der Hammen (Leiden) recognizes a mixture of Mesozoic and Cenozoic elements, but suspects that they represent foreign material concentrated along cleavage planes as, after cleaning fragments ultrasonically, he found the matrix practically barren.

As to interpretation of the significance of the fossil pollen and spores, two sharply divided opinions have been expressed. The writers make no attempt to adjudicate, but state the two concepts impartially.

One group adopts the attitude that the radiometric dating[5-7] of dolerites and a hornfels[6] within the Roraima Formation as Precambrian is beyond dispute, hence the pollen (and spores) must have entered as secondary contamination. The improbability that pollen could withstand the baking process, which converted shale to hornfels, is adduced as further evidence that the pollen must be allochthonous. The absence of macroscopic plant remains in the Roraima Formation is also noted, despite its assumed continental (?fluviatile) origin. It is admitted that entry of the pollen into its present site defies simple explanation, though some form of washing in by meteoric waters in the geological past via joints in the overlying sandstone seems the most probable cause.

The second group holds that by no conceivable physical means could the pollen (and spores) have entered the metamorphosed sediments from the outside. They are dense impermeable rocks compressed by an overburden of hundreds of feet of the overlying Roraima sandstones. The undercutting at Cerro Venamo suggests that the cliff has been steadily retreating, hence the face which was sampled must have been deep within the formation until quite recent times. The Roraima sandstones are quartzitic, of low permeability, hence carriage of extraneous pollen through them by percolating water seems highly improbable. Even if this process could occur, entry of such pollen and spores into the non-porous hornfels lacks an explanation. Furthermore, if plausibility of this process be granted, it would have been operative for a long period, and a mixed suite of spores and pollen should be expected.

In counter-argument against the first group, it is claimed that the assertion that pollen and spores cannot withstand anaerobic baking of their parent shales has never been tested experimentally. As regards the radiometric dating, there is a disquieting overlap between stated ages of the Roraima Formation[5,6] and the underlying basement rocks[7-9]. The latter suffered complex deformation and vulcanism, and were then deeply peneplaned before being covered by thousands of feet of Roraima sandstones, and only after these prolonged events were the dolerites intruded, on which age-determination of the Roraima has been based. If the radiometric technique is valid there should be a long and clear-cut time-gap between ages assigned to the basement rocks and to the Roraima beds. Such a gap does not exist in the experimental results published, but this discrepancy is glossed over in the latest summary of radiometric dating in British Guiana[7].

As stated, we offer no solution to the paradox. It is clear, however, that botanist Dunsterville in his hunt for rare orchids stumbled on a highly intriguing geological problem.

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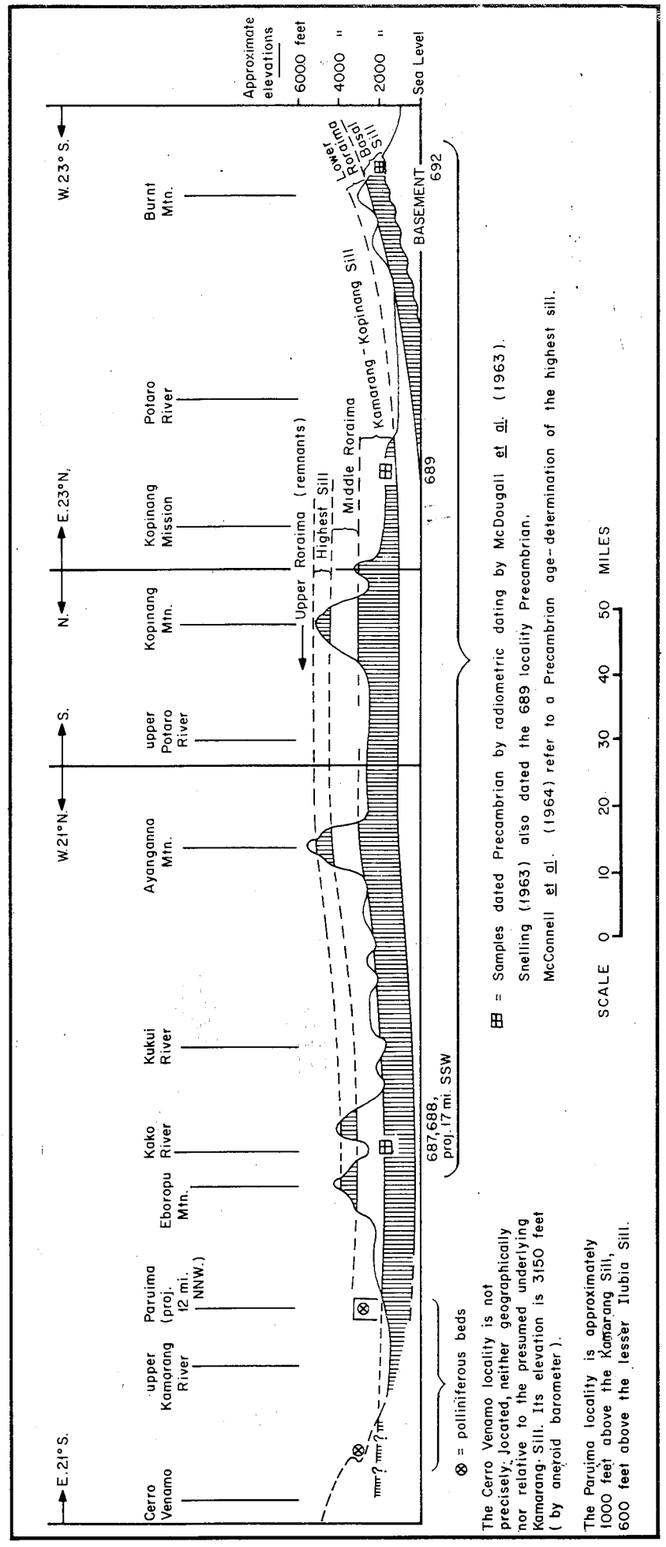

Figure 3: REGIONAL CROSS SECTION THROUGH THE RORAIMA FORMATION IN WESTERN BRITISH GUIANA (showing positions of polliniferous beds and of samples determined radiometrically as Precambrian).