



PRIVY COUNCIL

MEDICAL RESEARCH COUNCIL

SPECIAL REPORT SERIES No. 250

**CHRONIC PULMONARY DISEASE IN
SOUTH WALES COALMINERS**

III.—EXPERIMENTAL STUDIES

- A.—REPORT BY THE COMMITTEE ON INDUSTRIAL PULMONARY DISEASE**
- B.—THE MINERAL CONTENT OF THE LUNGS OF WORKERS FROM THE SOUTH WALES COALFIELD** by E. J. King and G. Nagelschmidt
- C.—THE ESTIMATION OF COAL AND OF ALUMINIUM IN DRIED LUNG** by E. J. King and Margaret Gilchrist
- D.—TISSUE REACTIONS PRODUCED EXPERIMENTALLY BY SELECTED DUSTS FROM SOUTH WALES COALMINES** by T. H. Belt and E. J. King
- E.—THE SOLUBILITY OF DUSTS FROM SOUTH WALES COALMINES** by E. J. King

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The late Dr. R. L. RAWLINSON was also a member of the Committee at the time of these investigations.

PREFACE

This Report deals with the experimental section of the investigation of chronic pulmonary disease in South Wales coalminers which the Medical Research Council undertook in 1936 at the request of the Home Office and the Mines Department. It is complementary to two Reports already issued, one on the medical survey and related pathological studies, and the other on environmental studies—physical, chemical and petrological (*Spec. Rep. Ser. Med. Res. Coun., Lond.*, No. 243, 1942 and No. 244, 1943). The whole scheme of inquiry has been directed for the Council by their Committee on Industrial Pulmonary Disease, who have provided covering reports for each of the three publications, reviewing and summarizing the conclusions of the investigators. The Council are indebted to the members of the Committee—and particularly to the Secretary, Dr. E. L. Middleton, O.B.E.—for their labours.

This third publication completes the account of the investigations which have been made under the particular scheme. It is clear from the reports however, that many questions still remain unanswered and that further research of different kinds is needed for their elucidation. The Council have accordingly in view an extended programme of investigation, to be put in hand as soon as circumstances permit.

2nd March, 1945.

MEDICAL RESEARCH COUNCIL,
c/o London School of Hygiene and Tropical Medicine,
Keppel Street, London, W.C.1.

CONTENTS

	PAGE
A.—REPORT BY THE COMMITTEE ON INDUSTRIAL PULMONARY DISEASE	iv
B.—THE MINERAL CONTENT OF THE LUNGS OF WORKERS FROM THE SOUTH WALES COALFIELD, by EARL J. KING and G. NAGELSCHMIDT	1
C.—THE ESTIMATION OF COAL AND OF ALUMINIUM IN DRIED LUNG, by EARL J. KING and MARGARET GILCHRIST	21
D.—TISSUE REACTIONS PRODUCED EXPERIMENTALLY BY SELECTED DUSTS FROM SOUTH WALES COALMINES, by THOMAS H. BELT and EARL J. KING ..	29
E.—THE SOLUBILITY OF DUSTS FROM SOUTH WALES COALMINES, by EARL J. KING	69

(Detailed Tables of Contents precede Sections B to E.)

CHRONIC PULMONARY DISEASE IN SOUTH WALES COALMINERS.—III. EXPERIMENTAL STUDIES

A.—REPORT BY THE COMMITTEE ON INDUSTRIAL PULMONARY DISEASE

1. This is the third Report on a series of studies directed by the Committee on Industrial Pulmonary Disease towards the elucidation of the problem of chronic pulmonary disease in the coalminers of South Wales. The first Report (*Spec. Rep. Ser. Med. Res. Coun., Lond.*, No. 243, 1942) dealt with the results of a medical survey and pathological examinations, and, simultaneously with the survey, investigations were made of environmental factors which may play a part in the causation of the disease. While the first Report showed that airborne dust must be regarded as the factor primarily responsible, the second (*Spec. Rep. Ser. Med. Res. Coun., Lond.*, No. 244, 1943) was directed to a consideration of the physical and chemical nature of the dust to which the miner was exposed, and to the chemical and petrological characteristics of the coal-seams and immediately adjacent rock strata from which the dust is derived. In their introductory report to the second monograph, the Committee suggested that the variations in the incidence of pneumokoniosis might depend on differences in the dusts, and they mentioned that some experiments had been begun to explore this possibility and to throw light on the relative pathogenicity of the different components of the dust, and of mixtures of these components.

The present Report includes accounts of the analysis of the mineral deposits found in the lungs of workers in the South Wales coalfield, of an experimental study of the tissue reactions produced in the lungs of experimental animals by selected dusts from the South Wales coalmines, and of a study of the solubility of such dusts.

2. In an extensive investigation, Professor King, Dr. Nagelschmidt and Mrs. Gilchrist have determined the composition and concentration of coal and mineral dust found at autopsy in the lungs of 54 coal workers. The composition of the lung residue varies for different occupational groups, in accordance with differences in the dust-producing strata encountered. In the lungs of anthracite colliers there was no significant increase in dust, total silica or quartz with increasing degrees of fibrosis. In the whole series of lungs, however, there was significantly more quartz in the silicotic nodulation category than in the less severe fibrosis groups. The investigators consider quartz, rather than mica or kaolin, to be the chief hazard, and they discuss the various ways in which the quartz effect might be so modified by the other dust constituents as to produce the lung changes observed.

3. In their experimental investigation of the effects on the lungs of rats of different specimens of dust obtained from the South Wales coalmines, Dr. Belt and Professor King have used the late Professor E. H. Kettle's method of introducing the dust in a single large dose directly into the trachea. A large number of mineral dusts and mixtures of dusts was studied in this way. In this connexion, it must be borne in mind that the experimental method employed takes no cognisance of the time factor, which may be of importance in the naturally occurring disease in man when dust has gradually accumulated in the lungs over a period of years. On the other hand, the exposure of

experimental animals to various dusts under conditions similar to those of workers in industries in which silicosis is known to occur is difficult and may equally be fraught with possible fallacies.

Dr. Belt and Professor King find that the purest coal dust, whether anthracite, steam coal or bituminous, has a low pathogenicity and causes only minimal fibrosis, but that the pathogenicity becomes greater as the content of siliceous material in the coal dust increases. Shale dust was found to be of low pathogenicity, and so were certain isolated "silicate dusts" consisting of fairly pure mica. The pathogenic action of quartz dust was substantially reduced if it was mixed with shale dust. When quartz dust was mixed with coal, the resultant confluent fibrosis was in distribution and type more like that seen in pneumokoniosis occurring in coal workers than that characteristic of the effect of pure quartz dust. The reasons for the pathogenicity of some siliceous dusts and the relative harmlessness of others are, however, by no means clear. Although the present investigation has given certain definite pointers, it is necessary that more experimental work should be done.

4. In recent years the deleterious effect of silica has been attributed to the toxic action which it can produce on the tissue cells when it is in solution. Professor King has investigated the solubility of silica in the different specimens of dust obtained from the South Wales coalmines, and the factors in such dusts which may depress the solubility below that characteristic of pure silica, particularly the effect of aluminium in various forms. But although it may be true in general that the more soluble a siliceous dust, the greater its toxicity, many variations from this generalization are shown in the South Wales mine dusts studied by Professor King. At least a partial explanation can be offered for these discrepancies, but it is again clear that a satisfactory answer must depend on further investigation.

5. The results of the medical studies described in the Committee's first Report raised two important questions:—

- (i) What are the cause and the mechanism of production of the pneumokoniosis of coal workers, and what is its relation to "classical" silicosis?
- (ii) Why does the incidence of pneumokoniosis amongst colliers in South Wales decrease with the rank of the coal mined, from high in anthracite to low in bituminous coal?

The data presented in the present and previous Reports suggest that, while quartz is probably the most noxious factor, the difference between this pneumokoniosis and "classical" silicosis (as seen, for example, in sandstone workers) is due to small amounts of quartz being mixed, in the former case, with large amounts of coal and other minerals, as has, indeed, been suggested by others who have studied the problem. The mechanism of the interaction of quartz with other silicates and with coal—and the possible antidotal effects of aluminium, iron, etc.—require further study, which the Committee regards as a matter of great importance.

The relationship of incidence of pneumokoniosis to rank of coal might be due to a generally higher dust concentration in anthracite mines, to differences of interaction of quartz with different types of coal, or to differences of the modification of the quartz effect, due to differences in the mineral composition of the shales and other strata associated with the coal. The published Reports show that all these effects may be involved in causing the differences in pneumokoniosis incidence. But despite the great amount of information elicited, many doubts and discrepancies have still to be dispelled, and the Committee feel

PULMONARY DISEASE IN SOUTH WALES COALMINERS vii

that it would be imprudent at this juncture to draw any firm conclusions. They agree with those who have carried out the investigations, that much further study is necessary of the reaction of the lungs of animals to the different components of mine dust, tested both individually and in different combinations, as well as of the factors which affect the solubility of silica and silicates in the body fluids; and that this information must be correlated with the features which characterize pneumokoniosis as it develops in man under the every-day conditions of his work.

6. The Committee wish to thank the investigators for the care and skill with which they have carried out these laborious researches. They also wish to express their high appreciation of the work of their Secretary—Dr. E. L. Middleton, O.B.E.—which has proved invaluable throughout the whole inquiry covered by the three Reports; the constant and critical alertness which he has maintained, together with his great experience, have overcome many of the difficulties which the Committee would have otherwise encountered, and have enabled the investigations to be continued in spite of the handicap imposed by the war.

The Committee have learnt with very great regret of the untimely death of Dr. T. H. Belt, which occurred while this Report was in the press. The Committee owe much to him, and his work published in the first of the three Reports, and in the present monograph, has formed a very important contribution to the study of the pneumokoniosis of coal workers. It is indeed regrettable that he should not have lived to continue the experimental work which he had developed with such ability.