STATUS OF INDIAN COALS IN UNIVERSAL CLASSIFICATION OF SOLID FOSSIL FUELS

G. K. B. NAVALE AND B. K. MISRA

Birbal Sahni Institute of Palaeobotany, 53, University Road, Lucknow—226 007

ABSTRACT

While evaluating the status of Indian coals on the Universal Classification model for solid fossil fuels proposed by ALPERN (1981) we encountered certain problems. In solution of these problems we have proposed a new group for coals of intermediate (or mixed) type and modified the classification model.

INTRODUCTION

So far, there is no internationally accepted classification for solid fossil fuels useful for geologists. The existing and the only one classification accepted universally is that proposed at Geneva in 1956. This classification, based mainly on chemical parameters, is in numerical codes and concerns only with washed coals. Beside this, there are several national classifications of different countries utilizing rank, denoted by volatile matter-content and calorific value. These individual (national) classification charts are rather difficult to correlate among themselves, e.g. a French "lignite" is classed as "sub-bituminous coal" in America.

Considering the inherent problems and discrepancies with the existing national and international (numerical code) classifications, ALPERN (1979a & b) proposed a classification model for universal usage, which encompasses solid organic deposits from lignite to anthracite on one hand and from pure lignite/coal to shale on the other. After slightly modifying his earlier classification for solid fossil fuels, ALPERN (1981, I.C.C.P. draft proposal) proposed a new model based primarily on micropetrological characteristics, i.e. rank (reflectance of vitrinite), type and facies. ALPERN's (1981) classification model approaches to qualify different types of solid fossil fuels and to collect geological and commercial information on a uniform scientific basis for specific economic utilization, global comparison and evaluation of the fuel reserves.

Based on the above concept, we plotted micropetrological data of Lower Gondwana, Mesozoic and Cenozoic coals of India. In doing so we met with certain basic difficulties which necessitated some modification and restructuring of the Alpern's Universal Classification Model (ALPERN, 1981).

CLASSIFICATION

The classification proposed by ALPERN (1981) consists essentially of three parameters : (i) the type designated by proportions of inertinite, vitrinite and liptinite (exinite) maceral groups, (ii) the rank, in terms of reflectance of vitrinite in oil, and (iii) the facies denoted by ash content as deduced from proximate analysis on run of mine coal.

These parameters are arranged in such a way that the data plotted would reflect a triaxial diagram. The coals have been designated FUSIC, VITRIC and LIPTIC types on the basis of maceral groups inertinite, vitrinite and liptinite (exinite). He has

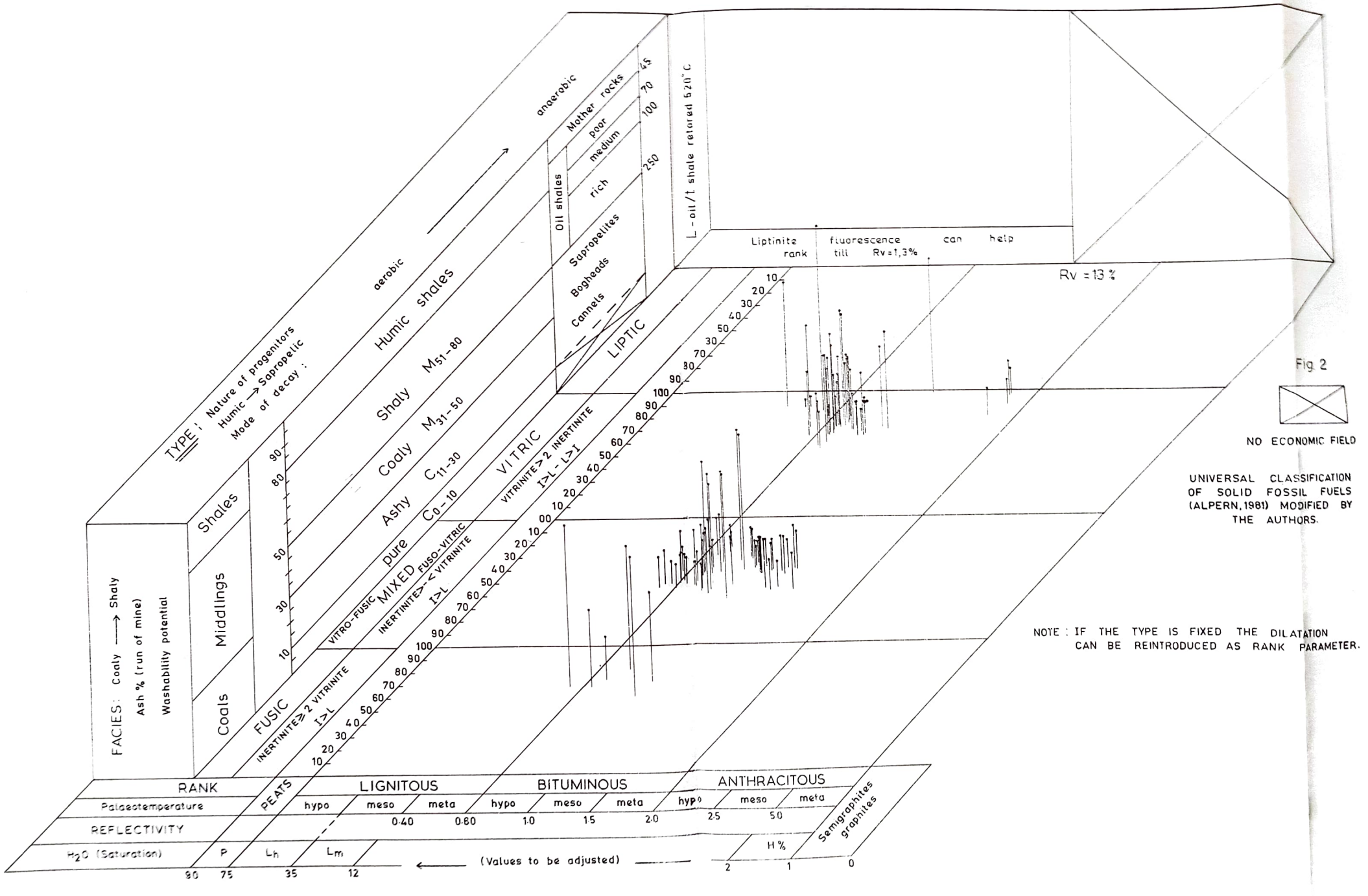

Fig. 2

NO ECONOMIC FIELD

UNIVERSAL CLASSIFICATION OF SOLID FOSSIL FUELS (ALPERN, 1981) MODIFIED BY THE AUTHORS.

NOTE : IF THE TYPE IS FIXED THE DILATATION CAN BE REINTRODUCED AS RANK PARAMETER.

quantified FUSIC coal with vitrinite less than 65 per cent whereas, no fixation for the proportion of inertinite has been done except that the inertinite is more than the liptinite. The VITRIC coal contains more than 65 per cent vitrnite while inertinite is either more or less than liptinite. The LIPTIC coal comprises less than 65 per cent vitrinite and the amount of liptinite is more than inertinite. The vertical column (facies column) represents coal, middling and shale ascribed on the basis of ash content. The horizontal column depicts rank (reflectance of vitrinite). The range of reflectance values encompasses coalification stages from (peat) lignite to anthracite (semigraphite-graphite) (for further details of the Alpern's Universal Classification see ALPERN, 1981, fig. 5).

While plotting petrographic and rank data to ascertain the status of Indian Permian (Lower Gondwana), Mesozoic and Cenozoic coals the data particularly of Lower Gondwana coals never conformed with the classification given by ALPERN (1981). A modification of the scheme became necessary to suit the Lower Gondwana coals of India. We apprised Prof. ALPERN of our problems and suggestions (*Pers. Comm.*, 1982). He advised that the maceral group plottings should be made on pure maceral basis (mineral matter free, or m.m.f.) instead as recorded from the petrographic analysis. Plottings based on pure maceral basis solved minor problems but major problems concerning coal types remained as such; for example—maceral group composition of four Lower Gondwana coals (values in parenthesis are on pure maceral basis or m.m.f.)—(a) Vitrinite 36.25 per cent (60.66%), Inertinite 18.00 per cent (30.12%) and Mineral matter 40.25 per cent (Ash—59.75%); (b) V—31.50 per cent (63.00%), I—12.00 per cent (24.00%) and M.M.—50.00 per cent (Ash—55.00%); (c) V—40.00 per cent (58.82%), I—16.00 per cent (23.53%) and M.M.—32.00 per cent (Ash—35.20%) and (d) V—46.00 per cent (56.76%), I—20.50 per cent (25.31%) and M.M. 19.00 per cent (Ash—20.90%) render them to be classed as FUSIC type as all of them contain less than 65 per cent of vitrinite. On the contrary, they are vitric in nature as is evident from their vitrinite contents which are more than twice the inertinite contents. Besides this, significant proportion of the Indian Permian coals being mixed or intermediate type, they cannot be classified properly as no category for such coal type has been provided in the model, e.g., (a) V—30.00 per cent (33.29%), I—52.90 per cent (58.71%) and M.M.—9.90 per cent (Ash 10.89%); (b) V—52.70 per cent (58.49%), I—35.40 per cent (39.29%) and M.M.—9.90 per cent (Ash—10.89%) and (c) V—37.00 per cent (14.34%), I—36.00 per cent (40.22%) and M.M. 10.50 per cent (Ash—11.55%). These samples exhibit varying frequencies of vitrinite and inertinite ranging from inertinite more than vitrinite, inertinite almost equal to vitrinite and vitrinite more than inertinite but all of them would be classed as Fusic type by ALPERN's (1981) proposal. In fact, they have intermediate composition between the typical FUSIC and VITRIC Types. These problems appear to have stemmed out, partly, due to designation of the FUSIC, VITRIC and LIPTIC Types based mainly on vitrinite maceral group. Thus, the possible variation in the coal types, particularly in FUSIC and VITRIC coals caused by the inertinite maceral group could not be covered up reasonably well.

In view of the preceding problems encountered in the Universal Classification Model of ALPERN (1981) we have attempted for a solution and suggested certain modifications for the restructuring of the model (Fig. 1) keeping the original idea of ALPERN (1981) intact in the case of RANK and FACIES part. In doing so, we presume that the Universal Classification Model should be able to categorize, with ease, all the varieties of coals and lignites into their rank and natural types, including the range from pure-coal, middling, humic shale and shale. Moreover, such a clearly demarcated types, as FUSIC,

VITRIC and LIPTIC in coals, particularly as has been proposed by ALPERN (1981) is rarely found in India. It may be true for certain areas but the same cannot be presumed to be applicable every where. A range of variation in maceral composition from FUSIC to VITRIC coal types with a transition or intermediate stage normally expected in coals should be accounted for while devising any classification model for universal usage. Thus, our modification is mainly an introduction of 'Mixed coal type' to facilitate incorporation of coals and lignites showing intermediate or transitional maceral composition ranging from vitro-fusic to fuso-vitric varities between FUSIC and VITRIC coal types and quantitative delimitation of the coal types in terms of maceral composition.

Regarding delimitation of coal types we have presumed that the Fusic coal type should be typically fusic in nature with high proportion of fusinite in relation to vitrinite and be recognized, primarily, with its fusinite content. Whereas, vitrinite in the Fusic coal should also be quantitatively fixed. Likewise, the Vitric coal type should be identified by its vitrinite content with high amount of vitrinite in comparision to fusinite and the proportion of intertinite present should be adjusted accordingly. The range of maceral composition between Fusic and Vitric coal types, thus, left uncovered will be taken care of by the newly designated MIXED coal type.

Based on the preceding discussion, the FUSIC coal type has been qualified as consisting of two or more than two times the inertinite maceral group than the amount of vitrinite. The MIXED coal type has been proposed to possess maceral group composition ranging from inertinite more than vitrinite (Vitro-fusic) to vitrinite more than inertinite (Fuso-vitric). The VITRIC coal type has been ascribed to contain vitrinite maceral group twice or more than twice the proportion of inertinite maceral group. In case of LIPTIC coal type the classification model is still open for consideration due to the dearth of sufficient petrographic data available with us for any generalization. Nevertheless, we suggest that the LIPTIC coal type should be recognised by the liptinite content and the delimitation should be made either with respect to liptinite and vitrinite or with liptinite and inertinite considering better suitability of the preceding maceral group combinations.

For the purpose of plotting, proportion of inertinite maceral group has been selected by virtue of its over dominance in the FUSIC coal type. Whereas, in the case of Mixed coal type inertinite fraction has been considered suitable again as it is still appreciable in amount and ranges from more than (vitro-fusic) to less than (Fuso-vitric) the proportion of vitrinite. For the VITRIC coal type the vitrinite maceral group being over dominant has been selected for plotting. We have converted the total mineral matter recorded to obtain Ash content by the formula suggested by CHATTERJEE *et al.* (1968) and employed the latter values for plotting. Since, only petrographic data alongwith rank (Ro max. in oil) has been used as the two classification parameters for the third one (Ash content) we suggest that mineral matter recorded petrographically and converted into ash content as suggested by CHATTERJEE *et al.* (1968) should also be considered as a substitute in case we lack the ash content obtained directly from run of mine coal by chemical (Proximate analysis) method. This proposal if accepted will facilitate the classification of solid fossil fuels based entirely on micropetrological methods. As regards chemical parameters we should utilize them for the purpose of correlation with the micropetrological data which will be useful for prediction of technological behaviour of coal. Thus, the scope of the chemical parameters in this aspect will not be reduced.

Petrological and rank data for the present plottings of about 133 samples (Fig. 1) have been accumulated from Palaeozoic (Lower Gondwana sequence-Permian, 115

samples), Mesozoic (3 samples) and Cenozoic (15 samples) coal basins of India. The data for Permian coals have been gathered from four major basins, viz. Damodar (Jharia, Raniganj, East Bokaro, Hutar, and Daltonganj) Satpura (Pench-Kanhan Coalfield), Son-Mahanadi (Kurasia, Katkona Talchir, Korba, and Singrauli coalfields) and Wardha-Godavari (Umrer, Kothagudem, Yellandu or Singreni, Ramkrishnapuram, Ramagundam and Belampalli or Tandur coalfields) basins. The Mesozoic coal samples represent Guneri, Chawad and Trambau areas of Kachchh Basin. The data utilized from Makum Coalfield (Namdang, Baragolai, Ledo-Tirap and Tipang collieries) of Assam; Rongreggiri, Lakadong and Daranggiri coalfields of Meghalaya and Jangalgali, Chakkar and Kalakot coalfields of Jammu-Kashmir areas represent the Cenozoic coals.

Plotting of all the 133 sample data (Fig. 1) revealed that most of the Indian Lower Gondwana coals (115 samples) are either mixed type (65 samples or vitric in natu e (62 samples) whereas, true fusic coals (6 samples) are rather rare. All the Mesozoic and Cenozoic coals are of vitric type without exception. Among the Mixed type of the Lower Gondwana coals, two separate groups have been clearly demonstrated according to their rank, i.e., low and high rank, grading imperceptibly from vitro-fusic to fuso-vitric. The high rank mixed coal type are mostly fuso-vitric in nature with few exceptions and apparently, represent coking coals of Indian Lower Gondwana Sequence. Similarly low rank Lower Gondwana (Permian) and Cenozoic vitric coals are distinctly separated from semi-anthracites (Cenozoic coals) of Jammu-Kashmir areas. The overall assessment of the plotted data have shown that :

(i) the fusic coal consist of inertinite proportion ranging from 30.04 to 62.00 per cent (60.00 to 31.27% on pure Maceral basis). The vitrinite content varies from 6.45 to 14.60 per cent (7.00 to 29.16% on m.m.f. or pure maceral basis).

(ii) the inertinite maceral group frequency in mixed coal type ranges from 26.50 to 52.90 per cent (28.19 to 64.35% m.m.f. basis) whereas vitrinite fraction forms 17.65 to 55.60 per cent (30.56 to 61.23% on m.m.f. basis) and

(iii) the vitrinite macerals in vitric coal type ranges from 40.00 to 93.20 per cent (54.91 to 98.27% m.m.f. basis) while inertinite content varies from 2.33 to 26.20 per cent (2.35 to 30.29% m.m.f.).

It is evident from the preceding observations that the proportion of vitrinite and inertinite groups have an overlapping tendencies in the minimum and maximum values recorded from all the three coal types (Fusic, Mixed and Vitric). This validates the flexible but clear cut delimitations of the coal types proposed by us. Apart from this we have also observed that even after plotting the petrographic data on pure maceral basis (m.m.f.) no specific change could be obtained in the ultimate categorization of the coal types except the total shift of the points towards higher frequencies which was due to increase in the values of vitrinite and inertinite contents after being converted to pure maceral basis. Obviously, our proposal for the modification in the Universal Classification Model need no conversion of the data (on pure maceral basis) and we hope it would accommodate all possible varieties of coal and lignite. Thus, in our opinion, plotting the petrological data on pure maceral basis can be avoided because it does not provide the correct frequencies of the maceral groups recorded from the petrological study and renders difficulty in rapid and easy assessment of the coal and lignite characteristics.

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