Organic matter occurrence, maturation and source potential in Gondwana of South Rewa Basin

C.M. Berry

Palynology Laboratory, KDMIPE, ONGC, Dehra Dun

Berry, C.M. 1992. Organic matter occurrence, maturation and source potential in Gondwana of South Rewa Basin. *In* : Venkatachala, B. S., Jain, K. P. & Awasthi, N. (eds) – *Proc. 'Birbal Sahni Birth Centenary Palaeobotanical Conference', Geophytology* **22** : 115 — 118.

The studies on organic matter types, palynofacies and thermal alteration indices (TAI) of outcrop samples are conducted to evaluate hydrocarbon generating potential of the Talchir, Barakar, Pali and Parsora sediments of South Rewa Basin. The sedimentary organic matter recorded is mainly land-derived. The different stages of organic-biodegradation are well marked throughout the basin. Humic organic matter is dominant in Talchir and Barakar formations while Pali and Parsora formations comprise mainly of sapropelic-humic organic matter. Assessment of TAI values of organic matter suggests excellent maturation potential for Talchir Formation (TAI 2. 75 to 3.25) whereas the Barakar, Pali and Parsora show very good to good maturation level (TAI 2.5 to 2.75). The organic matter in these sediments is adequately matured, and is considered to have potential to generate hydrocarbons.

Key-words—Organic matter, maturation, hydrocarbon, Gondwana, South Rewa, India.

INTRODUCTION

THE determination of hydrocarbon source potential is based on considerable amount of data on quantitative and qualitative aspects of organic matter and its thermal alteration values (TAI).

The present area of study lies between latitude $23^0 0'$ to $23^0 35'$ N and longitude $81^0 20'$ to $81^0 55'$. E, covering an area around Shahdol, Anuppur and Jaintpur areas in Shahdol and Surguja districts, M.P.

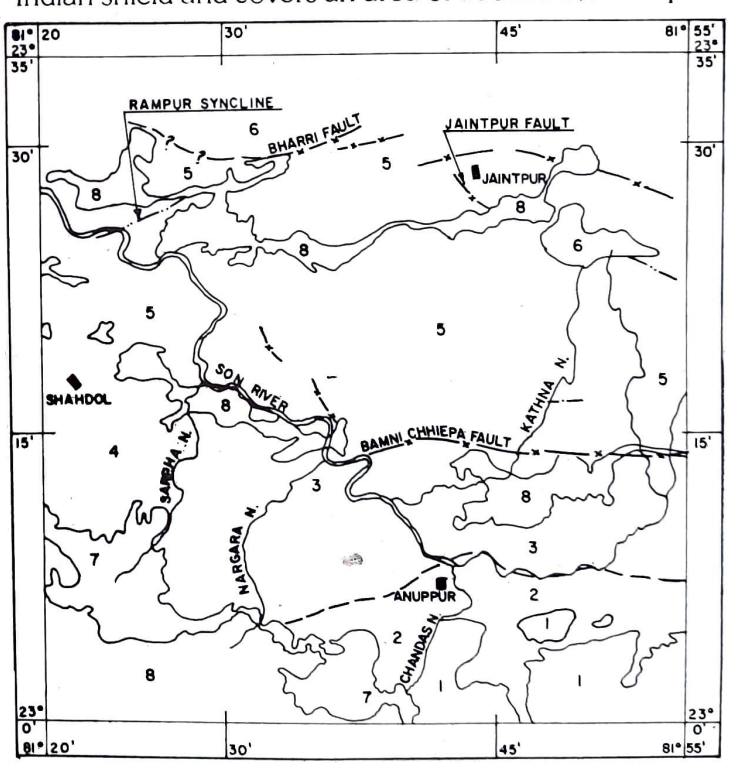
The samples studied were collected from three traverses, viz., Kathna Nadi, Chandas Nala, Nargra Nala and spot material representing, Talchir, Barakar, Pali and Parsora formations (Text-fig. 1).

GENERAL GEOLOGY AND STRATIGRAPHY

This basin has been explored for its rich coal potential, however, no attempt has yet been made to evaluate source rock potentials for hydrocarbons. Geological Survey of India has done some work dealing with geology and gravity magnetic surveys of the basin. The basin was first mapped by Hughes (1881), followed by Cotter and De (1917), Fox (1934), Dutta (1977), Banerjee (1964) and Mitra *et al.* (1977).

Asthana and Valluri (1984) reviewed the geological data and stratigraphy which are utilized in this paper.

The South Rewa Basin located on the northern part of the Son-Mahanadi Graben is an intra-cratonic basin in the Indian shield and covers an area of about 28,500 sq. km.



Text-figure 1. Location map of South Rewa Basin.

Table 1. Stratigraphy of South Rewa Basin (After Asthana & Valluri, 1984)

Age	Formation	Lithology	Approx. Thickness (m)
Recent	Alluvium		
Palaeocene	Deccan Trap/Dyke	Basalt and dolerite	
		Unconformity	
Late Cretaceous	Lameta	Sandstone, clay limestone, marl	50
		Unconformity	
Early Cretaceous	Bansa–Chandia	Massive sandstone, conglomerate, clays, shale and chert	100
		Unconformity	
Late Triassic	+ Parsora	Sandstone, mudstone,	450
	+ Pali–Tikki	Mudstone, red shale, siltstone	450–600
		Unconformity	
EARLY	+ Barakar	Grey brown sandstones, coals	175–900
	Karharbari	Grey carbonaceous sandstone Grit conglomerate with coal seams	60-120
	Umaria marine bed	Fossiliferous sandstone and clays	3–5
PERMIAN		Unconformity	
	+ Talchir	Sandstone, shale, boulder beds	15–400
	Manendragarh	Green Shale, sandstone	—
	Marine bed	Conglomerate	—
Pre–Cambrian	Basement	Granite, gneiss, schist, phyllites	—

\+ Formations studied

The basin is confined between longitude $80^0 45'$ -$83^0 45$ E and latitude $23^0 70'$-$24^0 15'$N. Geologically, it is delinited by Umaria-Korar Coalfield in the west, Deccan Traps in the southwest, Mahanadi Graben in the South, Pre-Cambrian basement in the southeast and east Narmada-Son Geofracture Zone in the north.

During the field season (1986-87), Chopra *et al.* (1987), geologists of the Oil & Natural Gas Commission carried out detailed geological mapping of the entire basin and collected samples along Kathna Nadi, Chandas Nala, Nargra Nala and some spot material. The present study is based on the surface samples of above traverses and spot samples (Text-fig. 1). A generalised stratigraphy, lithology and thickness of the sediments in the basin are given in Table 1. The traverse and sample locations for the present study are given in Text-fig. 1.

METHODOLOGY

Palynological techniques adopted for extraction of organic matter, spore and pollen are same as detailed by Berry (1989). Visual quantitative and qualitative estimates of various organic matter types identified in a basin are importent criteria used to define source rock characteristics of the sediments. Quantitative estimation of organic matter is done according to the method of Terry and Chilinger (1955). These percentages are expressed as: Abundant = 5%; Common (25-50%); Present (5-25%) and Traces (upto 5%). Such estimates are significant in facies analysis. In addition to this, qualitative assessment of the total organic matter is done on the basis of their biological source.

The organic matter types demarcated in South Rewa Basin are (1) structural terrestrial material, i.e., cuticle, epidermal remains and woody components; (2) spore and pollen; (3) biodegraded terrestrial organic matter; (4) amorphous organic matter and (5) fungal spores and hyphae (Masran & Pocock, 1981; Venkatachala, 1981 a,b). These types are utilized for interpreting palynofacies analysis. 'Humic', 'Sapropelic' and 'Mixed facies' are marked on the percentage volume and types of organic

matter which help in drawing useful conclusions for evaluation of hydrocarbon source potential of the basin.

Thermal alteration index (TAI) values based on the colour of spore and pollen are taken to measure thermal alteration level of organic matter. The TAI 1-5 scale of Staplin (1969) is used in this study. The immature/mature and metamorphosed thermal facies are detected and demarcated, according to the maturity scheme proposed by Staplin (1977, fig. 10). TAI value of 2.5 has been generally considered to be taken as the youngest level of mature facies or hydrocarbon generation threshold of organic matter.

SOURCE ROCK ANALYSIS

The Formation-wise palynofacies analysis is given below.

Talchir Formation

Organic matter—The organic matter recovered in general, is poor, however rich organic matter is observed in Kathna Nadi traverse. Humic organic matter is the dominant type while sapropelic matter is low in percentage. Semi-fusinitic matter is also present. Algal filaments, fungal spores and a single specimen of foraminifera are also recovered. The organo-facies is predominantly humic-sapropelic.

Thermal maturation—TAI values of 2.75 to 3.25 indicate highly mature facies.

Source potential—The sequence suggests a poor source rock character. The Kathna Nadi sediments, however, can be rated as excellent source rocks.

Barakar Formation

Organic matter—The sequence is comprised of rich humic organic matter. Sapropelic matter is low in frequency.

Thermal maturation—TAI values of 2.5^{+} to 2.75 suggest an adequate matured facies.

Source potential—Humic dominant mature organic matter facies indicates that the Barakars can be good source rocks for generation of gaseous hydrocarbons.

Lower Pali Formation

Organic matter—Rich organic matter is recorded. Sapropelic matter is dominant type, humic matter is common. The facies is predominantly sapropelic/humic one.

Thermal maturation—TAI values range from 2.5 to 2.75.

Source potential—The mixed sapropelic dominant-humic facies indicates a good source rock representation in the Pali sediments.

Middle Pali Formation

Organic matter—The sequence shows adequate organic matter richness. Humic matter forms the major organic matter type. Sapropelic matter is common. The facies is mixed humic-sapropelic type.

Thermal maturation—TAI values of 2.5 to 2.75 suggest an adequately matured facies. Exceptionally high TAI values of 2.75^{+} to 3.25 are also observed in few samples.

Source potential—The sequence possesses good source rock quality.

Parsora Formation

Orgainc matter—Rich amount of organic matter has been recovered in this formation. Sapropelic matter is present in abundance while humic matter is commonly distributed.

Table 2. Palynofacies and maturation in South Rewa Basin

Traverse	Formation	Palynofacies	TAI Range	Maturity
Kathna Nadi	Middle Pali	Humic/sapropelic	2.5 – 2.75	Good–very good
	Barakar	Humic	2.5^{+} – 2.75	Very good
	Talchir	Humic/sapropelic	2.75 – 3.25	Excellent
Chandas Nala	Talchir	Data poor	2.75	Very good
Nargra Nala	Barakar	Humic	2.75	Very good
Spot Samples	Parsora	Sapropelic/humic	2.5	Good
	Middle Pali	Humic/sapropelic	2.5–2.75 and 3 – 3.25	Very good to Excellent
	Lower Pali	Sapropelic/humic	2.5 – 2.75	Good – very good
	Barakar	Humic	2.5^{+} – 2.75	Very good
	Talchir	Data poor	2.75	Very good

Thermal maturation—TAI values are measured as 2.5.

Source potential—The Parasora sediments contain well matured mixed organic matter and are considered to be good source beds.

CONCLUSION

Terrestrially sourced organic matter constitutes the bulk of total dispersed sedimentary organic matter in South Rewa Basin. Humic organic matter forms dominant representation in Talchir, Barakar and Middle Pali sequences. Sapropelic matter is significantly abundant in Lower Pali and Parsora formations. The organo-facies is principally mixed type in the basin and varies from humic dominant to sapropelic dominant.

Trend of thermal maturity of palynofossils indicates that the Talchir sediments have excellent maturation (TAI-2.75 to 3.25, Table 2). The Barakars, Pali and Parsora sediments represent very good to good maturation index (TAI 2.5 to 2.75, Table 2). Certain samples of Middle Pali possess high maturation indices (TAI 2.75 to 3.25). The organic matter of these sediments is adequately matured.

The visual identification of palynofacies and its level of thermal maturation indicates that the South Rewa Gondwana sediments contain adequate source potential and are capable of generating hydrocarbons.

ACKNOWLEDGEMENTS

Sincere appreciation is expressed to Dr. S.K. Biswas, Director, KDMIPE for granting permission to publish this paper. Thanks are due to Shri Kuldeep Chandra, G.M. (G.R.G.); to Dr. J. Pandey (D.G.M.) Geology Division and to Shri Y.K. Mathur (C.P.). Officer-in-Charge, Palynology section for their constant guidance and valuable advice. The author is also thankful to Shri V.K. Chopra, Party Chief, GL 5 (1986-87) for providing the samples.

The views expressed here are of the author only and not necessarily of the organisation.

REFERENCES

Asthana, M., & Valluri, R.C. 1984. Geology and hydrocarbon potential of South Rewa Gondwana Basin. *Petroleum Asia Jour.* **1:** 200-206.

Banerjee, A.K. 1964. The sub-structures of the Rewa Gondwana Basin of M.P. *22nd Int. Geol. Cong.* Pt. **9:** 331-340.

Berry, C.M. 1989. Source rock palynology of Subathu sediments of Simla Hills. *Geophytology* **19** (2): 140-146.

Cotter, G. & De, P. 1917. A revised classification of the Gondwana System. *Rec. geological Surv. India* **48:** 23.

Chopra, V.K. Jainthram & Das, N.G. 1987. Geology of the area around Shahdol, Anuppur and Jaintpur, Distt. Shahdol and Surguja (M.P.)

Dutta, N.R. 1977. Talchir Glaciation in the Son-Mahanadi and Koel valleys and adjoining areas. India. *4th Int. Gond. Symp.* **1:** 360-367.

Fox, C.S. 1934. The Gondwana system and related formations. *Mem. Geol. Surv. Ind.* **58.**

Hughes, T.W.H. 1881. Notes on the South Rewa Gondwana Basin. *Rec. geol. Surv. Ind.* **14** (4) 120-128.

Mitra, N.D., Bose, V. & Dutta, P.K. 1977. The problems of classification of the Gondwana succession of the peninsular India. *4th Int. Gond. Symp. vol.* **2:** 463-469.

Masran, Th. C. & Pocock, S.A.J. 1981. The classification of plant derived particulate organic matter in sedimentary rocks. *In:* Brook, J. (Ed.) - *Organic Maturation Studies and Fossils Fuel Exploration:* 145-176. Academic Press, London.

Staplin, F.L. 1969. Sedimentary organic matter, organic metamorphism and oil and gas occurrence. *Bull. Can. Petrol Geol.* **17** (1): 47-66.

Staplin, F.L. 1977. Interpretation of thermal history from color of particulate organic matter— a review. *Palynology* **1:** 9-18.

Terry, R.D. & Chilinger, G.V. 1955. Summary of 'Concerning some additional aids in studying sedimentary formations' by M.S. Sharetsov. *J. sed. Petrol.* **25** (3): 229-234.

Venkatachala, B.S. 1981a. Differentiation of amorphous organic matter types in sediments. *In:* Brook, J. (Ed.) - *Organic Maturation Studies and Fossil Fuel Exploration: 145-176. Academic Press, London.*

Venkatachala, B.S. 1981 b. Hydrocarbon source rock evaluation-a new palynological approach. *Petroleum Asia Jour.* **2:** 79-93.