



## Coal petrography, mineralogy and geochemistry of lignite samples from the Ogwashi–Asaba Formation, Nigeria

Jude Ogala<sup>a</sup>, George Siavalas<sup>b</sup>, Kimon Christanis<sup>b,\*</sup>

<sup>a</sup> Department of Geology, Delta State University, P.M.B. 1, Abraka, Nigeria

<sup>b</sup> Department of Geology, University of Patras, 265.04 Rio-Patras, Greece

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### ABSTRACT

Organic sediments picked up randomly from seven small outcrops within the Ogwashi–Asaba Formation, southern Nigeria, are examined and evaluated by means of coal petrology and chemical and mineralogical analyses in order to determine the palaeoenvironmental conditions and the factors controlling their formation. Six samples proved to be low-rank coals C to B (lignite), one carbonaceous shale. The lignite samples display low ash yield, low telohuminite and high detrohuminite and liptinite contents; they contain small amounts of clastic minerals, mainly quartz and clays, which point to the topogenous character of the depositional palaeoenvironment. The palaeomires formed in a continental basin crossed by the mid-Tertiary palaeo-Niger River; the latter, as well as the tropical rainfall supplied the mires with water. The dense vegetation cover on the mire surface and the surroundings and/or the low relief energy of the broad area restricted the inorganic influx resulting in high-grade coal formation. As the outcrops are distributed over a distance of 60 km, the expected reserves of good quality lignite constitute a very promising exploration target.

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### 1. Introduction

Coal was the first energy source exploited in Nigeria before the discovery of petroleum reserves in the Niger Delta by the late 1950s. Coal outcrops in Nigeria have been indicated in more than 22 localities spreading over 13 States of the country (NCC, 1997). The proven coal reserves of Nigeria are estimated to about 639 Mt, while the inferred resources amount to 2.75 Gt (MOMSD, 2007). Current production of coal in Nigeria has been dropped to insignificant levels from its high of almost 1 Mt in 1959 as a result of the complete dieselization of the railways, the commissioning of the Kanji hydro-electric power station and the appearance of petroleum on the economic scene since 1958. Recent information (EIA, 2008) indicates production of only 10,000 short tons in 2005, down from peaks of 100,000 to 200,000 short tons in the 1980s and 1990s, respectively.

Nigeria's coal resources are located in the Lower, Middle and Upper Benue Trough (Akande et al., 1992; Obaje et al., 1999; Simpson, 1954). The Benue Trough of Nigeria (Fig. 1) is a sedimentary basin that extends in a NE–SW direction, from the Gulf of Guinea in the south to the Chad Basin in the north. The coal seams occur at three main stratigraphic levels (Fig. 2): the lignite of Ogwashi–Asaba Formation of Oligocene–Miocene age (Reyment, 1965), the

Upper (Nsukka Formation) and the Lower sub-bituminous Coal Measures (Mamu Formation) of Maastrichtian age (Akande et al., 1992; Reyment, 1965; Simpson, 1954) and the bituminous coals of the Awgu Formation of Coniacian–Santonian age (Akande et al., 1992; Obaje, 2009; Obaje and Hamza, 2000; Obaje and Ligouis, 1996; Reyment, 1965). Currently, exploration and exploitation of coal deposits in Nigeria take place at Enugu, Okaba, Ogboyoga, Orukpa and Lafia-Obi (Fig. 1) (Obaje, 2009; Obaje and Ligouis, 1996; Obaje et al., 1999).

Nigerian coal is generally characterised by low sulphur content, medium to high calorific value, low ash yield and low moisture, being therefore environmentally friendly and attractive for import by Ghana, Egypt and some European countries (NCC, 1997; MOMSD, 2007). Coal is used presently in Nigeria as a fuel in cement production, brick factories, foundries, laundries and bakeries, as important raw material base in tire and battery manufacture, and as substitute for fuel wood in domestic cooking (smokeless coal briquettes). Nigerian coal can be blended with imported coals for coke production, and it is projected (NCC, 1997) that as much as 200 kt per year of Nigerian coal could be directed to supply coke to the Ajaokuta Steel Plant located in Kogi State when it goes into full production.

The Nigerian lignite zone, of mid-Tertiary age, extends from Orlu in the southeast, through Nnewi, in a 16–20 km wide belt across the Niger River, to Ogwashi–Uku in Delta State (Okezie and Onuogu, 1985). In the west of River Niger, there are several

\* Corresponding author.

E-mail address: [christan@upatras.gr](mailto:christan@upatras.gr) (K. Christanis).

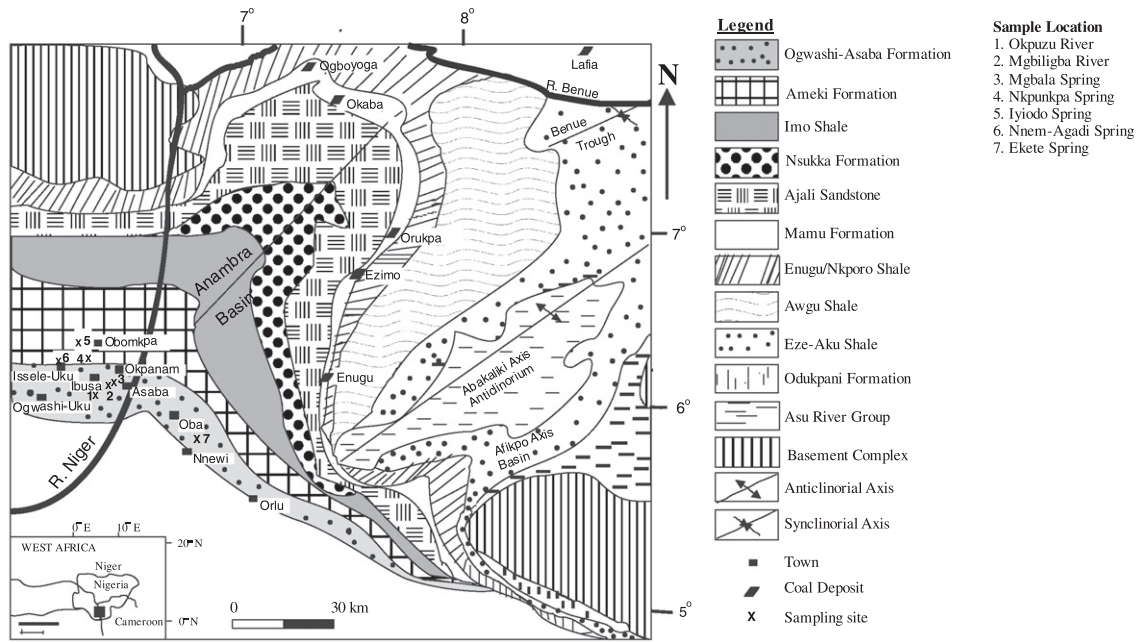


Fig. 1. Geological map of the Lower Benue Trough showing the known lignite deposits as well as the sampling sites (after Akande et al., 2007, modified).

Age	Geological Survey of Nigeria (1974)	Dessauvague (1974)	Petters and Ekweozor (1982)	
QUATERNARY				
TERTIARY	PLIOCENE	COASTAL PLAIN SAND	BENIN FORMATION	
	MIOCENE		OGWASHI-ASABA FM	
	OLIGOCENE	LIGNITE FORMATION	AMEKI FORMATION	
	EOCENE	BENDE AMEKI GROUP		
UPPER CRETACEOUS	MAASTRI-CHTIAN	FALSE BEDDED SST. UPPER COAL MEASURE	NSUKKA	
		LOWER COAL MEASURE	AJALI	
	CAMPANIAN	ASATA NKPORO SHALE GROUP	MAMU	NSUKKA FORMATION
			ENUGU SHALE	AJALI SANDSTONE
			OWELLI	MAMU FORMATION
				ENUGU & NKPORO
SANTONIAN	AWGU NDEABOH SHALE GROUP	AWGU SHALE	AFIKPO	
CONIACIAN		AGBANI	OWELLI	
MIDDLE CRETACEOUS	TURONIAN	EZE AKU SHALE GROUP	EZE - AKU	
			AMASERI	
	CENOMANIAN	ODUKPANI	ODUKPANI	
LOWER CRETACEOUS	ALBIAN	ASU RIVER GROUP	ASU RIVER GROUP	
			MAMFE	

Fig. 2. Stratigraphic subdivision of the Lower Benue Trough. (See above-mentioned references for further information.)

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