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Geology of Barcode type coking coal seams, Mecondezi sub-basin, Moatize Coalfield, Mozambique

G. Lakshminarayana *

Midwest Group, 8-2-654/3/25&26, Road No. 12, Banjara Hills, Hyderabad 500034, India

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ABSTRACT

The geology of Barcode type coking coal seams, including basin setting, stratigraphy, sedimentary facies, coal forming environments, seam morphology and implications for exploitation in the Mecondezi sub-basin, Moatize coalfield, Mozambique is presented. The Moatize coalfield is located along the Zambezi valley Gondwana rift that developed over heterogeneous Precambrian basement in between the Zambia and Zimbabwe cratons. Basement heterogeneities controlled basin development. Coal seams occur in a kilometer thick lower Karoo succession classified into Vuzi and Moatize Formations of late Carboniferous to Permian age. Coal seam stratigraphy, in ascending order, shows six seams namely the Sousa Pinto, Chipanga, Bananeiras, Intermedia, Grande Falesia and Andre. The Grande Falesia seam has attained a maximum thickness of up to 250 m, making it one of the thickest coal seams known so far in the world. Based on sedimentary attributes, the lower Karoo coal succession is classified into three facies assemblages, named Vuzi, Transitional and Moatize. The Karoo sedimentation commenced with the deposition of tillite, diamictite and rhythmite of Vuzi assemblage over Precambrian basement in periglacial environments during the late Carboniferous. The succeeding transitional assemblage is characterized by the presence of coal beds in association with diamictite, thereby signaling the onset of coal forming environments during the interludes of glacial retreat. The Moatize assemblage includes coal seams, mudstone, rhythmite and sandstone deposited in delta plain–mire environments. Coal seam morphology is Barcode in type and characterized by cyclic stacking pattern of thin beds of coal, carbonaceous mudstone and mudstone. High ash contents of the coal are attributed to flooding of low level mires and ground water fluctuations in a tectonically unstable basin setting. The coal is bituminous, vitrinite rich, medium to high volatile and medium in rank. As a coking coal, it compares well with some of the coking coals of Limpopo area in South Africa. Constraints on exploitation of Barcode type coal seams are linked to Barcode morphology, which can be overcome by selective mining of coal.

1. Introduction

The late Paleozoic–Mesozoic Gondwana basins located in Australia, Southern Africa and India resemble one another in regard to nature of clastic sediments starting with the late Carboniferous glacial boulder beds, periglacial diamictite–sandstone–rhythmite assemblage grading upward into Permian coal bearing successions. However, these coal basins display wide variation in their tectonic settings, depositional environment and coal qualities (Cadle et al., 1993; Cairncross, 1989 & 2001; Johnson et al., 1996; Semkiwa et al., 2003; Hancox and Gotz, 2014; Hobday, 1987; Pareek, 1988). The southern African Gondwana coal basins also known as Karoo basins located in South Africa, Zimbabwe, Botswana, Mozambique, Namibia and Tanzania are now broadly categorized into two types: 1) fore-arc—epicratonic basins with inertinite rich non-coking coals and 2) pericratonic rift basins containing vitrinite rich coking coals (Fig. 1). Basement heterogeneities controlled the basin development and nature of Permo-Carboniferous sedimentary fill in South Africa (see Hancox and Gotz, 2014 for review). In the context of evolution of coeval Indian coal basins, Lakshminarayana (1995) and Lakshminarayana (1996) demonstrated the influence of basement heterogeneities on coal basin development in the Gondwana rift settings.

Based on seam morphology, the coal deposits of the South African basins have been classified into two main types namely a) multiple seam type and b) thick interbedded seam type (Snyman, 1998, SANAS 10320, 2004). The multiple seam type deposits contain well defined coal seams with a thickness of up to 10 m, separated by inter seam partings commonly thicker than the coal seams. These are common in fore-arc/foreland epicratonic Gondwana basins, like the main Karoo basin of South Africa and Great Kalahari basin of Botswana and Namibia.

The thick interbedded type deposits contain complex coal seams consisting of cyclic beds of coal, carbonaceous mudstone and mudstone, with whole seam thickness attaining up to 75 m. These can be observed in pericratonic Gondwana basins located around the Zimbabwe craton including the coalfields of Limpopo area such as Waterberg (Grootegeluk

* Tel.: +91 9951699584.
E-mail address: glakshmi_1999@yahoo.com.

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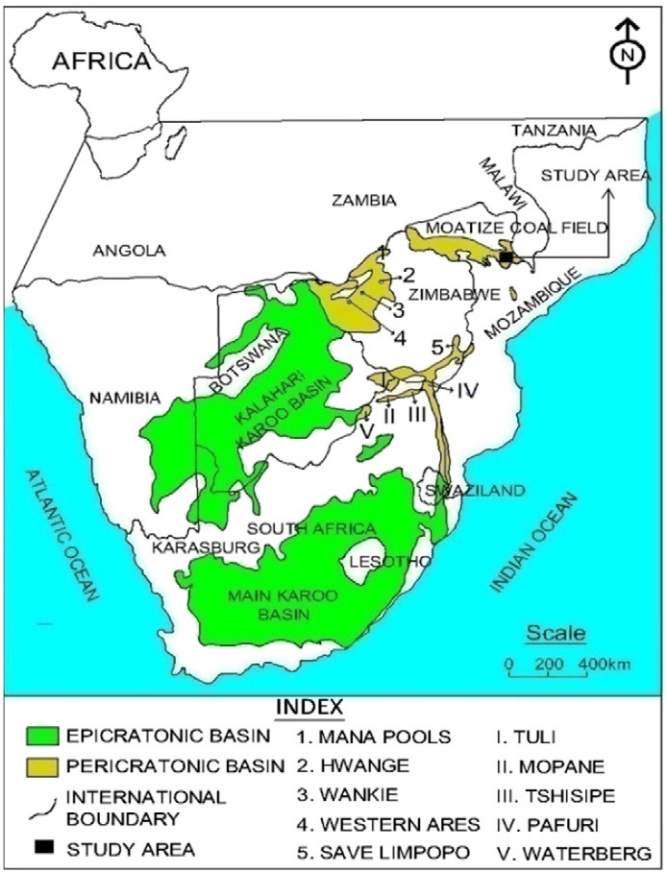

Fig. 1. Outline map of southern African coal basins showing location of study area.

Formation) and other coalfields in the vicinity such as, Mopane and Tshisipe in South Africa (Snyman, 1998); Western ares, Tuli and Mana Pools coalfields in Zimbabwe and Moatize coalfield in Mozambique (Lachelt, 2004) (Fig. 1).

The Karoo coal basin of the Zambezi valley Gondwana rift in Mozambique, described as Zambezi Basin (Lachelt, 2004) and Moatize Basin (Grantham et al., 2011), extends over a distance of about 350 km, between Mecucue in northwest and Muthrara in southeast, and is believed to contain several billion tonnes of coking coal resources. This coal basin was considered to be one of the least explored coking coal basins of the world up to 2007. In the present study, this coal Basin is referred under an Informal Name called the Moatize coalfield, after the coal mining Moatize town located in the east central part (Fig. 2a) and also due to the fact that the occurrence of coking coal has been established in different parts of the basin. Hatton and Fardell (2012) reviewed the geology of coal occurrences in Mozambique and proposed exploration methodologies for international resource reporting standards. Lachelt (2004) presented a succinct account of coal deposits in Mozambique. Nevertheless, there is a paucity of good quality outcrops of lower Karoo coal successions in Mozambique, thus one has to depend on core drilling data to comprehend various geological aspects. Although, several multinational coal companies like Rio Tinto, Vale, JSPL, etc. have undertaken intensive coal exploration by drilling from 2007 to 2013 in different parts of the Moatize coalfield, geological information made available in public domain has remained sketchy, perhaps due to the confidentiality policies of exploration and mining companies.

Geological surveys have been conducted by the author in different parts of the Moatize coalfield since 2008. Geological conceptualization and follow-up exploration campaigns have established a new coal deposit of thick interbedded type Barcode coal seams in the Mecondezi sub-basin (Fig. 2a), located in the northeastern part of the Moatize coalfield. An update on JORC compliant coal resource of new coal deposit has been released by the Midwest company, and is based on the

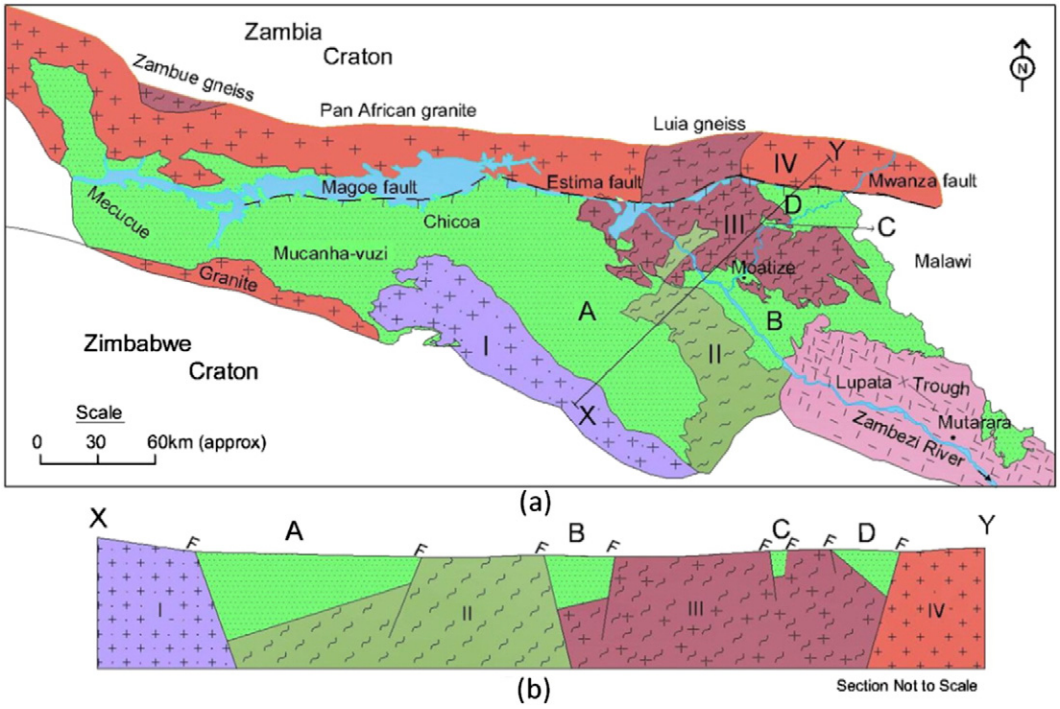

Fig. 2. a. Outline map showing tectonic setting of Karoo Basin along Zambezi valley in Mozambique. and b) Schematic geological cross section along X–Y. A: Sanangoe–Changara–Mefideze sub-basin, B: Moatize–Minjova sub-basin, C: NKondezi sub-basin, and D: Mecondezi sub-basin, I. Rushinga Group, II. B'arue' Group, III. Tete suite and IV. Granite and Gneiss. Green color indicates Karoo Basin fill. (Modified after Lachelt, 2004.)