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Petrographic characteristics and carbon isotopic composition of Permian coal: Implications on depositional environment of Sattupalli coalfield, Godavari Valley, India

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ABSTRACT

The present paper entails a study carried out on selected samples of coal and carbonaceous shales of Permian age from the Sattupalli open cast coal mine of Godavari valley, Andhra Pradesh to know their petrographic and chemical characteristics. Based on these characteristics, the depositional environment has also been discussed. The study reveals that these coals are sub-bituminous in rank and are chemically characterized by low to medium moisture (4.3 to 8.6 wt %) and volatile matter (24.5 to 32.6 wt %) while the ash yield varies between 16.4 and 35.3 wt %. Petrographically these coals are rich in inertinite. Liptinites occur in very small concentration. Collotelinite, collodetrinite and vitrodetrinite are the main vitrinite macerals whereas fusinite, inertodetrinite and semi-fusinite constitute the major proportion of inertinites. Mean $\partial^{13}C$ value measured for coal is $-22.58 \pm 0.20‰$ and for carbonaceous shale it is $-23.64 \pm 0.57‰$ while in the organic matter of Barakar sandstones the $\partial^{13}C$ is $-25.2 \pm 2.1‰$.

Dry periods are reflected by the abundance of inertinite in some samples while more anoxic conditions are indicated by high concentration of vitrinite in some samples. Seam-II of Sattupalli coalfield initially formed in dry condition and gradually flooding took place due to rise in the water table. During the formation of the upper part of the seam, again a relatively dry phase prevailed. Moreover, a positive correlation of $\partial^{13}C_{org}$ with TOC and a negative one with TIC indicate that $\partial^{13}C_{org}$ is being modified by $\partial^{13}C_{DIC}$.

1. Introduction

The Gondwana basins of Peninsular India are located along prominent river valleys, namely the Son, Damodar, Mahanadi, Godavari, and Satpura. Some of these Gondwana basins are characterized by prominent lineaments, faults and high heat flow values (Acharya, 2000; Shankar et al., 1991). Coal seams are interbedded with shales and sandstones and their deposition is controlled by the major tectonic lineaments in Precambrian basement rocks.

The Gondwana basin of Pranhita–Godavari Valley has been divided into four sub-basins, the i) Godavari, ii) Kathegudem, iii) Chintalapudi and iv) Krishna–Godavari coastal tract (Raja Rao, 1982; Fig. 1).

The tectonic history of the basin involved the initiation of the basin through general down warping of the basin floor. With progressive sedimentation the basin became a narrow graben bounded on both sides by NW–SE trending faults (Lakshminarayana, 1995). During the uplift of the Eastern Ghats, NE–SW trending post depositional transverse faults were developed. Records of terrestrial, marine and paralic deposits can be seen preserved in the sediments of Permian, Triassic, Jurassic and Lower Cretaceous in the Pranhita–Godavari basin. Navale et al. (1983) made a regional scale study of Godavari coals and their microconstituents while Pareek (1986) worked on the role of petrography to evaluate the coking/non coking nature of Godavari Valley coals (Raja Rao, 1982).

Among all the coalfields of the Godavari valley, the Sattupalli coalfield is new and has an open pit mine. Nearly 2 billion t of coal resource has been estimated from a 400 m thick coal bearing horizon of this coalfield. The focus of the present investigation is to characterize the petrographic and geochemical attributes of these Permian Gondwana coals and to understand their environment of deposition with the help of these data along with inputs of carbon isotope.

2. Geological setting

The Sattupalli coalfield is located along the southwestern margin of the Chintalapudi sub-basin which forms the southwestern part of

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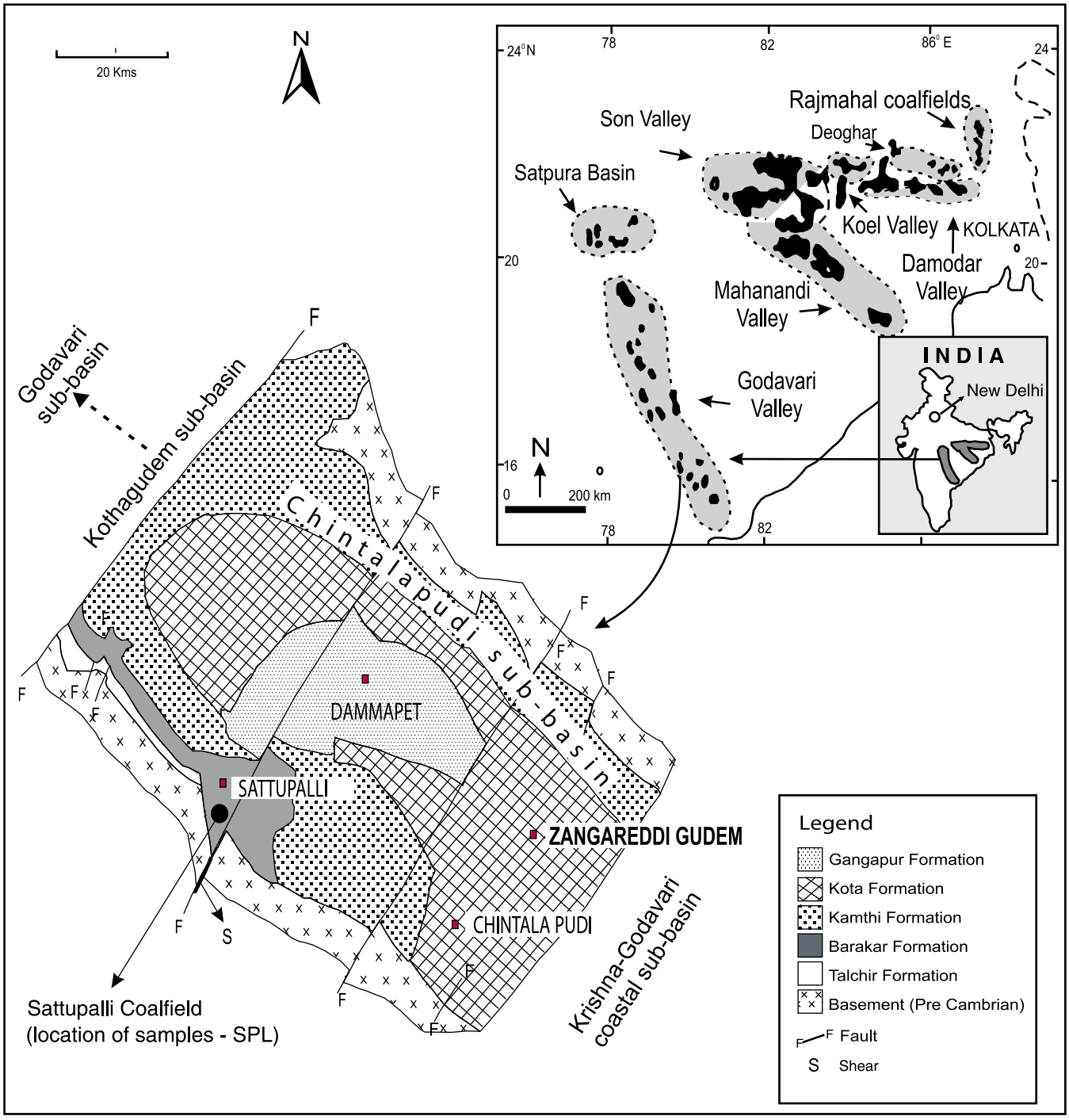

Fig. 1. Geological map of Sattupalli coalfield.

the NW–SE trending Godavari rift. This basin preserves 3100 m thick sediments deposited during Early Permian to Cretaceous in a graben framework. Stratigraphic succession of sediments, in ascending order, includes the Talchir, Barakar, Kamthi, Kota, and Gangapur Formations. These sediments are mostly fluvial deposits. There are two sets of faults, syndepositional NW–SE and post depositional NE–SW. The NW–SE faults formed the graben framework whereas the NE–SW faults transected the basin into secondary horst and graben blocks. These NE–SW transverse faults (basement rooted faults), being of post Gondwana age, have affected all the Gondwana formations (Raja Rao, 1982) in the area. Evidences of hydrothermal activity could be seen around Sattupalli coalfield resulting into sulfide mineralization along the faults, fractures and cleats; increased concentrations of rare earth elements (REE) and platinum group of elements (PGE) are also observed (Prachiti et al., 2011).

The general stratigraphic succession in the Sattupalli coalfield is, from base to top, the Talchir, Barakar and Kamthi Formation. The Talchir Formation includes khaki green shale, rhythmites and light green sandstone, which grade upward into white feldspathic gritty sandstone of the Barakar Formation. The Barakar Formation is well exposed in the Sattupalli coalfield and is divisible into two members, lower and upper. The lower member consists of white feldspathic gritty sandstone, whereas the upper member is made up of sandstone, shale and coal. Based on Th/U ratio, Prachiti et al. (2011) have