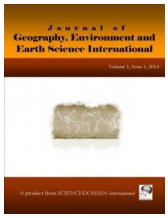

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Fossil Sites of Upper Catchment of River Dwarakeshwar, West Bengal, India

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

The Dwarakaswar river system is the sub watershed of the Gangetic delta of West Bengal. This is the dominant water flow of the western part of West Bengal, India. The upper catchment of Dwarakeshwar lies on the edge Tamar Porapahar Shear Zone and this upper catchment is the result of Proterozoic orogeny. Here, the basic principle of Hutton that is 'the present is the key to the past' has been followed. The study deals with intensive fieldwork with the identification of ontological sites of upper catchment of river Dwarakeshwar and here three fossil sites have been identified and plotted on maps. Three identified fossil sites are the stem of a woody plant, foot-print of early hominoids and a faunal fossil which appears like a Permian reptile. Those fossil sites are found vicinity to the river water line. Here the identified one wood fossil site and two faunal sites will be the positive impetus to the future study of palaeo-study of botany, zoology geology and geological and climate of western part of West Bengal, India.

Keywords: Petrified wood fossil; fossil of foot-print; Dwarakeshwar river basin; Palaeo Geographical Study.

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1. INTRODUCTION

The Dwarakaswar river system is the sub watershed of the Gangetic delta of West Bengal, India. This is the dominant water flow of the western part of West Bengal, India. The upper catchment of Dwarakeshwar lies on the edge of Purulia Bankura ductile shear zone with the Proterozoic formation [1]. But here the most of the land surface is the post-Pleistocene origin. The Dwarakeswar riverine area is the container of the geological history of Azoic igneous formation, Proterozoic-orogeny, Permo-Carboniferous glaciations, Gondwana shear zone, Pleistocene deposition and Tertiary terrain. The study of rock strata provides palaeo-climatic information. This region clearly depicts the evidence of a series of climate changes; arid to semi-arid climate in Cenozoic to Pliocene, Pleistocene glaciations to sub-humid climate in Quaternary (Holocene) era. This water course is the pre tertiary origin and the rock strata show the Palaeo history since the Silurian era (Paleozoic era) when warm and greenhouse era has started [1]. This water course has crossed a long path and the river has faced the several phases of lithospheric adjustment. The site and situation of river course are not only shifted, but since Silurian to Tertiary, this land mass has faced the tectonic hindrance too. This zone lies in the vicinity of the Tamar Porapahar Shear Zone. Here the three fossil sites on the river bank have been identified.

2. OBJECTIVE

Here the main objective of the study is to identify fossil sites in the upper catchment of Dwarakeshwar river basin area, district Bankura, West Bengal.

3. METHODOLOGY

This study is purely empirical (intensive field work and observation). The first step of this study was to carryout an intensive survey of the rock strata on the river banks. These rock strata survey include only the physical appearances, such as the structure or geometry, texture, colour, and the association with different minerals. The rock mineralogy were identified with the help of an optical microscope. The petrified fossil locations were identified and with the help of a Global Position System (GPS) and the coordinates of petrified fossil sites were collected and those are plotted on a map. The maps were prepared on the bases of the Survey of India topographical sheets (map no. 73I/15, 73I/16 and 73 M/3, R.F. 1:50,000) and the geological information derived from the geological map of the study area. The satellite imagery of Indian Remote Sensing (IRS 1C LISS III, path and row 106-55, respectively, on 1:50,000 scale) data was used to identify the location. These satellite images have been geo-referenced and merged using Q GIS (BIT 32) version of Image Processing Software. Here, the basic principle of Hutton that is 'the present is the key to the past' [2] has been followed.

4. STUDY AREA

The river Dwarakeshwar is 200 km long, flows in Bankura district, West Bengal (Fig. 1).The study area covers only the upper catchment (upto Bankura PS) of river Dwarakeshwar. It originates near the Tilaboni hill of District Purulia district. It flows side by the Shushunia hill (height 437 m, 23° 22' 30" N and 86° 58' 20" E) and it meets the Silaboti near Ghatal (East Midnapure) forming a confluence known as Rupnarayan. Its upper catchment is subject to sudden flood during rains (flash flood). The water course has crossed a long evolutionary path and its location has slightly altered through time. The tremendous shifting of river line has not been identified here, but the oscillation of river water line is very common in recent past.

5. RESULTS

The Pleistocene is the synonyms to the Paleolithic era [3]and early stone tool industry by hominoids are found in this riverine area [4]. Here the hominoids are not ancient like Olduvai gorge-hominoids but they are very similar to the ancient Narmoda man in central India. The Miocene has a dry history, but migration of fauna dominated during that era [5]. The Quaternary climate was favourable for survival for early hominoids. Here the foot-print fossil of early hominoid (Figs. 2, 3) depicts the strong and upright posture, strong heel strike, deep ball of the foot, hallux toe, and comparatively convergent toe [6]. In the mid of a foot, an arch shape is prominent (in between convergent toe and hill) and this curvature makes the balance of body weight (Figs. 2, 3) and mass. This fossilized foot-print provides an idea of the posture and gesture of early hominoids (Fig. 3).

A clear faunal petrified fossil (Figs 2, 4 Table 1) is observed and that is the clean imprint (Figs. 4a, b, c) of reptile (part of its fan in back). The

shape and gesture of petrified reptile are very similar to the Permian reptiles. The Permian is also marked for the great destruction [7]. The gesture of fossil is quite similar to Permian-Triassic tetrapod. Here the fossil of reptile depicts the fan like shape in the back (Figs. 4a, b, c). Here the undulating strip on the sandstone is the petrified relic of reptiles and which is very similar to the back-fan of the late Permian tetrapod. That petrified fossil site may act a positive impetus to study the Permian destruction in the western part of West Bengal. On the left bank of river Dwarekeshwar, the petrified stem (wood) fossil of a tree (Fig. 5) (in shale layer) lies in the lower most horizon and that depicts a wet climatic condition and high heat and abundance of carbon in the atmosphere. This petrified wood is quite similar to Mio-Pliocene sedimentary rock and here petrification mostly dominated by quartz and silicate [7]. The existence of petrified stem fossil (wood), petrified reptiles and fossilized foot print of early hominoids of Plio - pleistocene era give a clue that Plio-Pleistocene was the era of a productive ecosystem in the western part of West Bengal.

6. DISCUSSION

The river Dwarekeshwar is flowing over the very rigid and ancient craton (upper catchment). The river Dwarakeshwar is the Proterozoic origin [1] and its dominant tributary, the river Gandeshwari is the Silurian origin. The riverine zone touches the Tamar Porapahar ductile shear zone, which is the evidence of Proterozoic orogeny [1]. The Zaskar valley of Kashmir, Waddham of Madhya Pradesh, Manendragarh of Chhattisgarh, Balasinor of Gujarat, Suketi of Himachal Pradesh, Thiruvakkari of Tamil Nadu and Athnora of Madhya Pradesh are well explored zones of Indian fossil sites. A few study of Paleolithic stone tool industry and faunal fossil study were done by the Jadavpur University [8] in Sushunia hill zone, but the sites are not well defined and the upper catchment of river Dwarekeshwar remains unexplored [8]. Most of the Indian fossil site linked to a tectonic history [9] and this study area has crossed the phases of ductile shearing [1]. The petrification is the very natural phenomena, but it's very slow and continuous process and it takes million of years. The petrification can only explain by the cyclic time scale. It normally occurs when a living creature (after death or destruction by the terrestrial phenomena like devastating quake, faulting, warping, slumping, epirogenic upliftment etc., which normally occurs due to endogenetic forces of the earth) buries beneath the earth's surface. The decomposition is a very common fact in the case of buried living creature. But in the process of petrification, the organic mass (flora or fauna) is slowly replaced by the microscopic molecule of minerals and that mineral molecule slowly takes the shape of the organic mass (body) and that becomes rocky. This rocky (mineralized) structure appears identical to the shape and size (volume) of concern creature. Here mineral molecules take the exact shape of body by replacing the organic body mass. If flora or fauna has buried in such a way that atmosphere (air content, especially oxygen molecules) never comes in contact with the organic mass and that that has covered by the fine sand, clay or igneous or metamorphosed layer then the process of petrifaction starts. Ultimately, all the organic mass is replaced by the minerals and the minerals, ultimately takes the shape of organic mass. Here the wood fossil with quartz, quartzite with mica-fish indicates long and complex evolutionary history [10] and well as ductile shearing and that tectonic fact was responsible for petrification. Among the three fossils sites (Table 1), the petrified wood fossil is found in near the Kenjakura village of Chhatna Block, district Bankura (Figs. 5, 6) and this zone clearly show the evidence Proterozoic orogeny as well as ductile shearing [11] simultaneously.

This petrified stem wood fossil (Figs. 5, 6) is the reflection of Paleocene-Eocene Thermal Maximun with wet climatic condition [3]. The stem of this wood fossil is 2.6 meters long and its diameter is 1.2 meters (Figs. 5, 6) and that signifies the wet climatic condition [12] with the combination of high heat and abundance of carbon in the atmosphere. This petrified wood fossil is quite similar to Mio-Pliocene sedimentary rock [13] and here petrification mostly dominated by quartz and silicate [7]. The existence of carbon and iron oxide gives the petrified wood (stem) as a greenish black colour [14]. This floral fossil is the steam of a hardwood and the strata [15] are observed within layers of shale (Figs. 5, 6). Here upper part of shale is covered by the quartzite, black tourmaline (Fig. 8). Those are the evidences of high heat metamorphism [1]. Here Shale layer buried by ductile sharing (Fig.7) and wood fossil [16] comes out by the erosion and due to shifting of the river water line [17]. The Permian was the era of stem development of tropical vegetation [18] and the early Paleocene era was the period when the first recognizable plant species appeared on the earth and the

plants species [5] of that era were the ancient ancestor of modern species of rain forest [19] which are very hard and woody in nature. Actually, the Paleocene-Eocene boundary represents the development of subtropical vegetation species [7] in Indian sub-continent.

The second petrified fossil site is observed in between two villages; Banki and Ailta of Bankura PS and this site lie on the left-hand side of river Dwarakeshwar (Fig. 5). The mass extinction on the Indic and African continents (during Permian era) has been studied by the many palaeontologists. But the evidence of mass extinction on the Indian sub-continent is poorly defined. Permian was the period of change in terrestrial ecosystem and the terrestrial ecosystem faced a challenge of survival [7]. The mammal-like reptiles and a few amphibians were adversely affected by Permian climate [7]. Here the second petrified fossil site helps to get an idea about the species diversities during Permo-Carboniferous age and also it provides an idea about extinct reptile (during Permo-Carboniferous) of the terrestrial earth (from India sub-continent). The third fossil site is the foot - print of early hominoid and it is observed in Rampur (Fig. 3), block of Bankura and it lies in right-hand side of river Gandeshwari (dominant tributary of river Dwarakeshwar). It appears from various evidence that Dwarakeshwar–Gandeshwari inter fluve zone was a suitable site for the habitation of early hominoids [4]. Here the terrain like landform provided raw material for the stone tools (early Paleolithic industry by early hominoids) and the sharp quartz, quartzite- pebbles and nodules horizon [4] gave impetus to the palaeolithic tools and the relics of stone tools were recovered from the deposits along the river where the water flowed over a considerably steep gradient during the rains. The horizon of the fossils is most common on the weathered sandy silt of the late Pleistocene era when the region had forested and waterlogged evidently after a wet phase. The existence of early hominoids cleared forms the fact, fossil [19] of foot-prints found in Rampur of Bankura block (Fig.3). The foot -print lies in shale layer which is the product of early Pleistocene formation [16]. The bi-padal morphology of hominoids is the plio-Pleistocene origin and here big toe line in comparison of the back part of the foot indicates considerable diversity in bi-pedal locomotor of Pleistocene hominoids. The foot-print of early homo-sapiens lies in shale layer of Dwarakeshwari-Gandeshwari inter-basin area (Fig.3). The shape and size of foot-print depict the tentative height and weight (body mass index) of the early hominoids. This foot-print is quite similar to the early homo-sapiens of the Narmada Man. The Narmada Man is appropriately identified as early Homo-sapiens in Indic mass. The fossil records of early hominoids of Narmada give clues about the origin of bi-pedalism and foot morphology. Here the foot-print fossil indicates the existence of early hominoids during Pleistocene and the foot-print pattern depicts the similarity of the hominoids groups with Narmada Man.

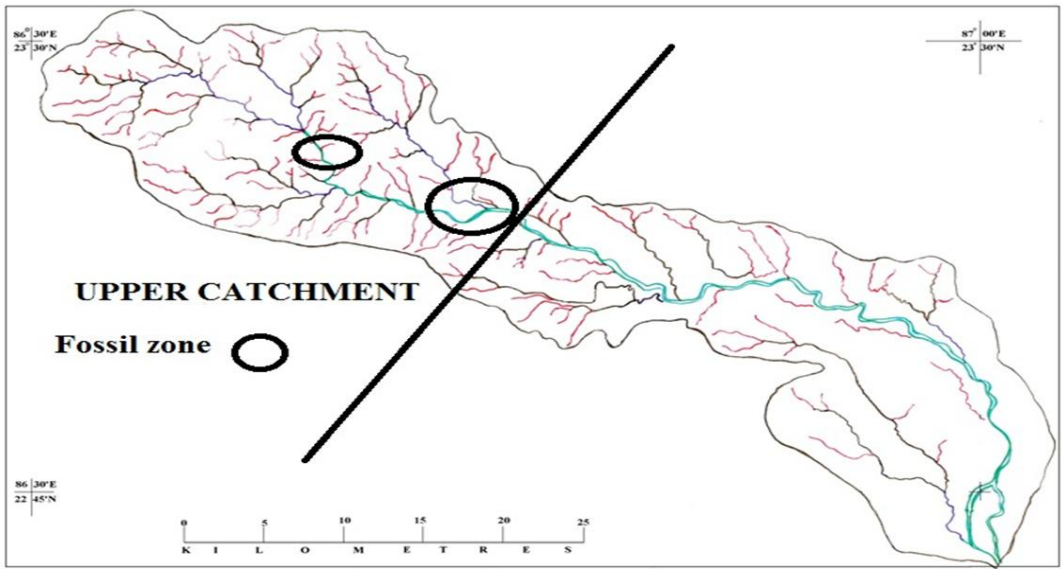

Fig. 1. Dwarakeshwar river basin

Table 1. Fossil sites of Dwarakeshwar river basin area (Upper Catchment)

Sl. no	Fossils	Rock type	Co ordinates	Description
1	Petrified Wood	Shale and Quartzite	$86^0$54'38''E &$23^0$15'35''N	Woody appearances Fine grain of shale layer Grayish in colour Close association with water line. Association of Quartzite in topmost layer is very common association
2	Petrified Reptile	Sand Stone and Conglomerate	$87^0$08'18''E & $23^0$13''55'N	Elongated shape(share is quite similar to quaternary snake) Sandstone with conglomerate 150 meters away from present water line Sand colour rocks
3	Fossil of a foot Print	Shale	$87^0$04'17''E & $23^0$14'23''N	Foot print of right toe Sixe is quite big than the foot size of Homosapiences Shale layer Fine grain Blackish to greenish in colour 100 m away from Gandeshwari water line.

Source: Identified by the Survey during 2015-16 June

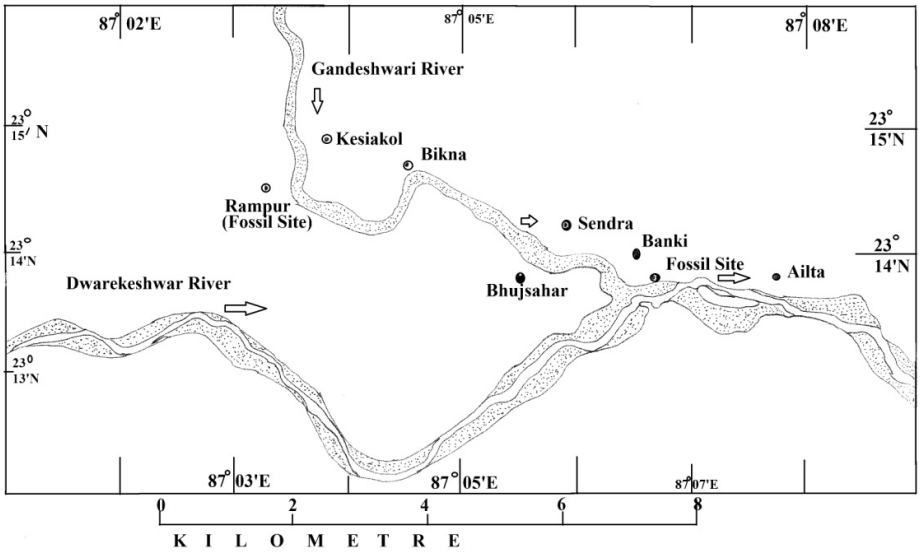

Fig. 2. Fossil sites of Dwarakeshwar basin (foot print of early hominoids and relic of part of reptile skeleton)

Fig. 3. Fossilized foot print (found in Rampur, Bankura, West Bengal, India)

The rock strata of the upper catchment of river Dwarakeshwar clearly shows the evidence of ductile shearing [1]. An association of tourmaline, feldspar, quartzite and quartz vein (Figs. 7, 8), anorthosites, amphibolites with shale layer are the clear evidence of ductile shearing [3]. Here the ductile zone with book shelf sliding (Fig.7) [11] clearly indicates every possibility that the organic mass has crossed the phases of mass under thrust [20]. The ductile shear zone responsible for the displacement of surface vegetation and the high heat metamorphism made vegetation detached from the atmosphere or air contact. The ductile shearing was responsible for the dislocation and sudden burial of floral species. The abundance of silicate, quartz, feldspar indicates the process of silicification, calcification, feldspathization. The top most layer covers with quaternary sediment and conglomerate. Here, that kind of geological association supports the petrification processes.

Fig. 4a. Fossilized relict of part of skeleton

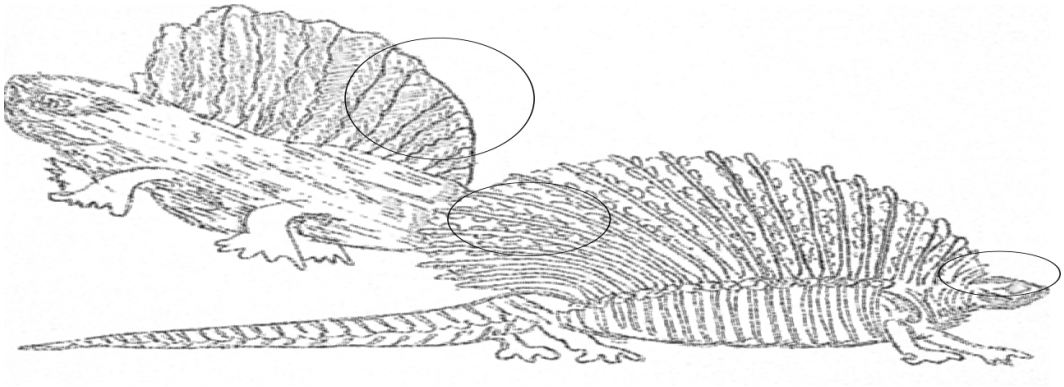

Fig. 4b. Graphical presentation of reptile

Fig. 4c. Fossilized relict of part of the skeleton of reptile (rock strata: shale to conglomerate, part of the body: strip of the back fan, found: left hand side of river Dwarakeshwar)

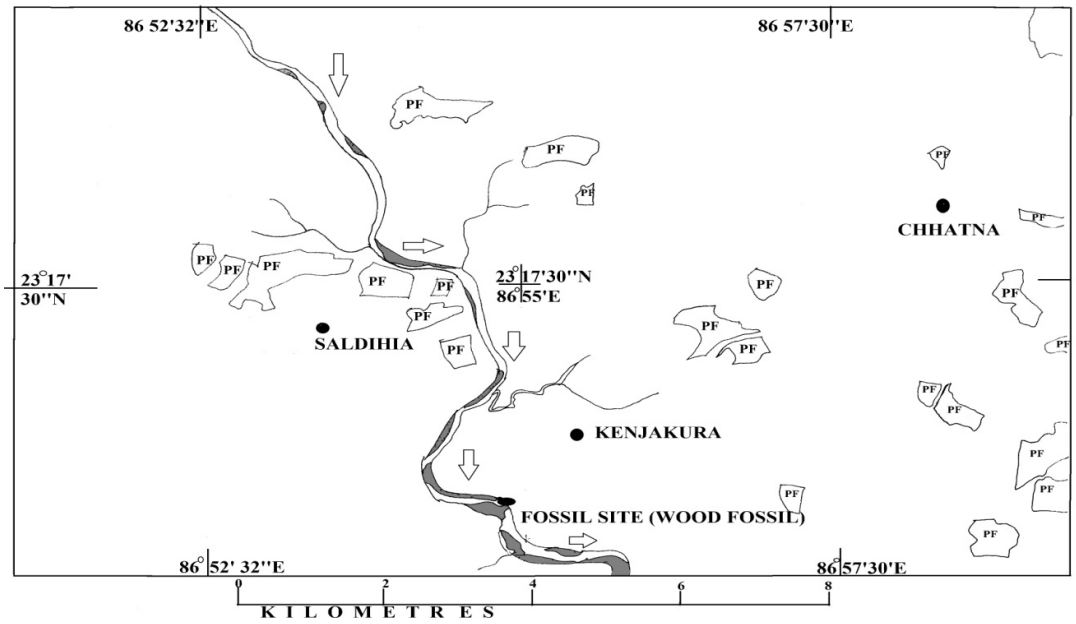

Fig. 5. Wood fossil sites of site of Dwarakeshwar basin

Fig. 6. Petrified wood fossil site: Kenjakura, Bankura, West Bengal, India Rock-strata: shale, Blakish gray)

Fig. 7. Book shelf sliding (shear zone)

Fig. 8. Tourmaline,quartz, quartzite and arenites (reflection of humid climate , high heat metamorphism and Proterozoic water flow)

7. CONCLUSION

The upper catchment of Dwarakeshwar river is the living relic of geo-climatic evolutionary history (as river Narmoda) since Azoic to Tertiary and the evidences are observed in wood fossil, faunal fossil and fossilized foot-print of early hominoids. The identified wood fossil with ductile shearing is the relic of palaeo - tectonic activities and as well it will provide a clue to the study of Plio-Pleistocene ecosystem in the western part of West Bengal. The identified fossilized reptile site helps to study the Permian faunal diversity in the western part of West Bengal. On the basis of identified thrice fossil sites, the upper catchment of the Dwarakeshwar river basin may be considered as an example site for the empirical research centre of Palaeo-geology, Palaeo-geography and Archaeology in the context of western part of West Bengal.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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