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Geology and Mineral Resources of Some Districts of Pakistan: Recent Found Paleontological Sites and New Titanosaur from Pakistan and First Diplodocid Dinosaur from Indo-Pakistan and Asia

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Abstract

Geology and mineral resources of some districts of Balochistan, South Punjab, Sindh and Khyber Pakhtunkhwa (KP) provinces of Pakistan are being presented. Recently found paleontological sites from the marine and terrestrial strata of Paleozoic, Mesozoic and Cenozoic era of Pakistan; a new titanosaur with some updates on Pakistani titanosaurs; and first diplodocid dinosaur from Indo-Pakistan subcontinent and Asia discovered possibly from the Middle Jurassic red/maroon strata of Shinawari Formation of Pakistan are being described. *Safisaur* is the first dinosaur from the Khyber Pakhtunkhwa Province of Pakistan. *Safisaur* is the first diplodocid dinosaur from Pakistan and also in Indo-Pakistan Peninsula and Asia.

Keywords

Geology, Minerals, Districts, South Punjab, Sindh, Balochistan, KP, Fossil Sites, New Titanosaur, First Diplodocid Dinosaur from Indo-Pakistan and Asia

1. Introduction

Previously the geology and especially mineral resources are commonly reported at provinces and country level, basin wise, quadrangle and locality wise and part of districts ([1]-[10], and references therein), while here district wise being reported which is useful for researchers, mine owners and planners. Dinosaurs (and many other biota) were reported since 2000 to so far [11]-[48], but here recently found paleontological sites, new titanosaur with some updates on Pakistani titanosaurs and first diplodocid dinosaur from Indo-Pakistan subcontinent and Asia discovered from Kohat area of Khyber Pakhtunkhwa province of Pakistan are being presented.

Institutional Abbreviations: GSP, Geological Survey of Pakistan, Quetta, Pakistan; BC, Boston College, USA; UM, Museum of Paleontology, the University of Michigan, USA; KUST-DM, Kohat University of Science and Technology, Department of Microbiology, Kohat (Pakistan).

2. Materials and Methods

Materials were collected during numerous field visits in many seasons in different areas of Pakistan and also previous published records. Methods applied here are description of different disciplines of geology such as stratigraphy, structures (foldings include anticline and syncline, and faults) and paleontology. In stratigraphy the law of superposition is applied. The younger rocks caped the older rocks. The tectonic structures such as folding are deduced by dip methods and core rocks. The anticline hosts older rocks in core and younger rocks in the limbs, while syncline hosts younger rocks in the core and limbs have older rocks. Mineral resources are identified by its physical and optical properties. Paleontological taxa are identified by diagnosis of autapomorphies and comparison with other taxa.

3. Results and Discussion

Results and discussion presented in 4 steps. 1st step includes the Geology and Mineral Resources of some districts, 2nd step includes recently found fossils sites, 3rd step on a new titanosaur description with some updates on Pakistani titanosaurs and 4th step the first Diplodocidae dinosaur from Pakistan and also Indo-Pakistan and Asia.

3.1. Geology and Mineral Resources of Dera Ghazi (DG) Khan and Taunsa Districts of South Punjab, Larkana, Qambar Shahdadkot, Dadu and Jamshoro Districts of Sindh, Jhal Magsi, Kachi, Lasbela and Mastung Districts of Balochistan, Tank, Bannu, Laki Marawat and Karak Districts of Khyber Pakhtunkhwa (KP), Pakistan

DG Khan and Taunsa Districts are located in middle Indus, Tank, and Bannu Districts are located in middle and upper Indus, Larkana, Qambar Shahdadkot, Dadu, Jamshoro, Jhal Magsi, Lasbela and Mastung Districts located in lower Indus, Kachi District is located in lower and middle Indus and Laki Marawat and Karak Districts located in upper Indus basins. Stratigraphy of each district is shown in relevant basin (**Figure 1**). Stratigraphic Groups are shown in [3] [4]. Faden Quartz may be found in sedimentary and ophiolitic complex rocks found north of Zhob city.

Geology and Mineral Resources of Dera Ghazi District of South Punjab: DG Khan, Rajanpur and Taunsa districts of south Punjab host mountain of Koh Sulaiman Range. The geology and mineral resources of Rajanpur district is also recently presented [49], while DG Khan and Taunsa districts are being presented here. DG Khan District area (**Figure 2**) represents alternating Zinda Pir anticline (at core Early Paleocene Rakhi Gaj sandstone and shale exposed near the Zinda Pir ziarat), Sakhi Sarwar syncline (core Sakhi Sarwar sandstone, conglomerate and muds) and Choti Bala anticline, all are trending N-S with low to moderate dips. Based on exposed strata in DG Khan District and surrounding areas, many petroleum reservoir levels are interpreted (same as in Taunsa District, see below). DG Khan District host gypsum deposits and cement raw materials (limestones, gypsum and clays/shale), uranium mineralizations, coal and carbonaceous shale. Further ironstone showing in Oligocene Chitarwata Formation, limestone and marl deposits from Drug, Habib Rahi and Pirkoh formations, vast shale and clay deposits from Shaheed Ghat, Baska, Domanda and Drazinda Formations and also in Chitarwata, Vihowa, Litra and Chaudhwan formations of Vihowa Group. Ochre showings in Drazinda, Chitarwata and Vihowa formations, rare celestite

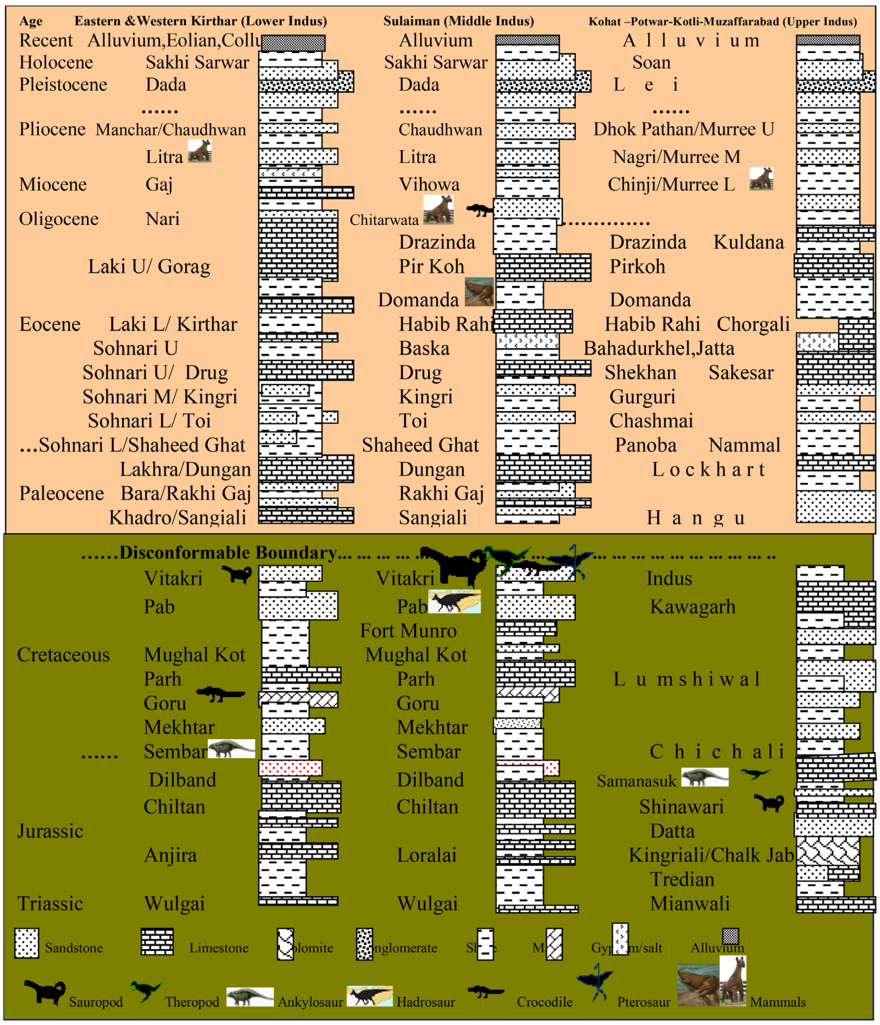

Figure 1. Revised Stratigraphic Correlation chart of North/Upper Indus (Kohat-Potwar-Kotli-Muzaffarabad) basin, Middle Indus (Sulaiman) basin and South/Lower Indus (Eastern and Western Kirthar) basin of Pakistan. Present discovery added the diplodocid (Flagellicaudata; Diplodocoidea) sauropod dinosaur in Bathonian Shinawari Formation (Figure updated after [3] [4]).

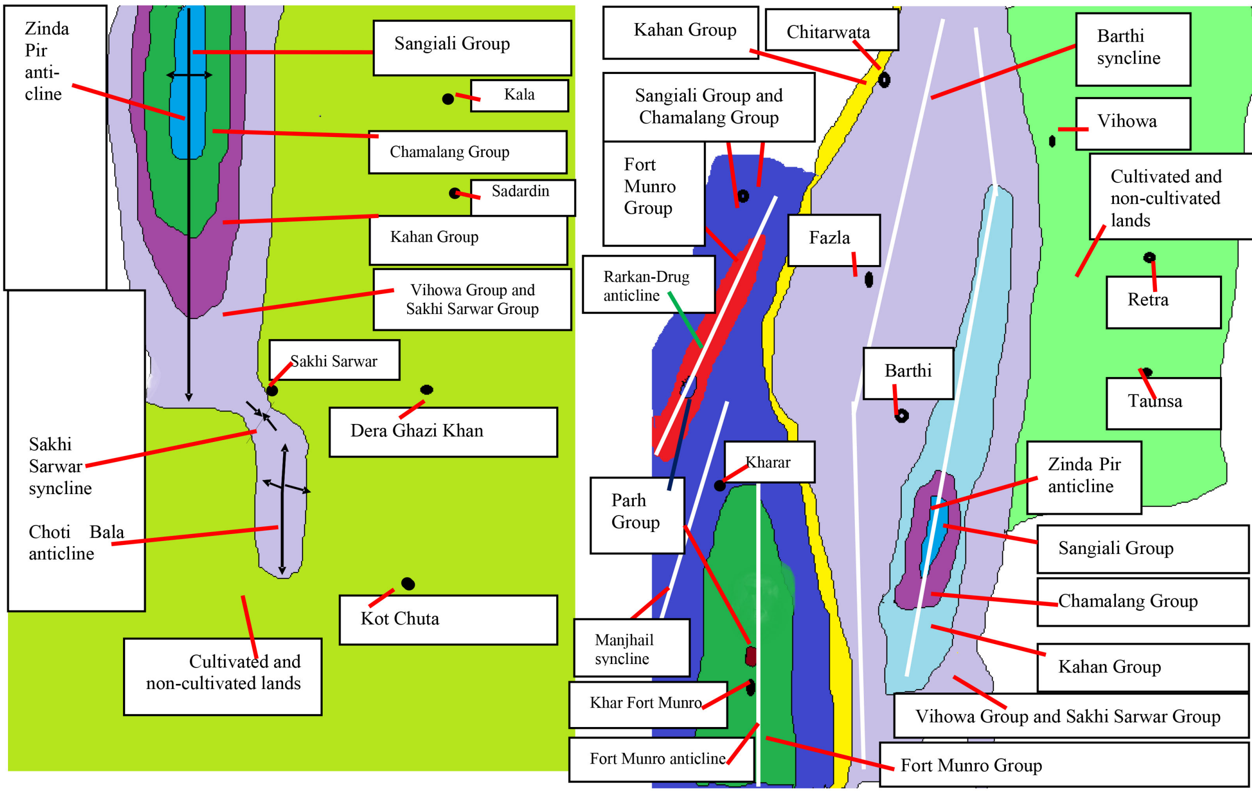

Figure 2. Geological maps of Dera Ghazi Khan District (left) and Taunsa District (right) of South Punjab (Pakistan). Not on scale. Geological Formations of each Group can be seen in [3] [4]. Black circles show town/city. White lines show anticlinal and synclinal axis in Taunsa District. Black lines show anticline and syncline in D.G. Khan District, while black arrows show dip inclination. Dip inclinations are mostly moderate and normal (not overturned) according to structures *i.e.*, trending outward the axis of anticline and trending toward the axis of syncline. Red lines are pointer to show geological groups, anticlines and syncline.

showings in Drug and Baska formations, gemstones and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others hosted in placer deposits of Oligocene to recent, construction materials from Drug, Habib Rahi and Pirkoh limestones, gravels from conglomerate of Vihowa and Sakhi Sarwar groups and alluvium in eastern limb and southern plunge of Zinda Pir anticline, and resistant (to erosion) and high density (heavy) minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, monazite and xenotime (REE bearing), and light minerals (which are significant) and lithium bearing minerals and others in placers. Sand from Indus River and its east west flowing tributaries, possible agrominerals like phosphatic nodules/shales and different clays like fuller earth, bentonite and fireclays from Chamalang, Kahan and Vihowa Groups were found. Constructions of smaller to medium sized dams are vital at different rudkohi/streams/nalas in mountainous areas to storage flood water for agriculture and home use. Many vertebrates from Cenozoic were also reported. The excavation and development of these geological resources, construction of water dams and installation of more cement and gypsum industry play a significant role for the economic growth of region and ultimately South Punjab and country Pakistan. The uranium showings and interpreted different petroleum levels in area of DG Khan District are the best energy resources.

Geology and Mineral Resources of Taunsa District of South Punjab: Taunsa District includes Taunsa, Vihowa and Koh e Sulaiman Tehsils. Structurally the southern part of Koh Sulaiman Tehsil (**Figure 2**) represents (west to east) alternating Rakhni syncline, Fort Munro anticlinorium (core Parh limestone at Shadiani), Barthi syncline (core Pliocene aged Chaudhwan Formation and Pleistocene aged Dada Conglomerate and Holocene aged Sakhi Sarwar Formation) and Zinda Pir anticline (core Early Paleocene Rakhi Gaj sandstone and shale); all are generally trending N-S with low to moderate dips. Structurally the central part of Koh Sulaiman Tehsil represents (west to east) Rarkhan-Hinglun Burg Pusht-Drug thrusted anticline (core Goru marl/shale), Manjhail syncline (core Drazinda shale), Hikbai-Mubarki anticlinal northern plunge of Fort Munro anticlinorium (core Mughalkot marl/mud), Barthi syncline and Zinda Pir anticline trending N-S with low-moderate dips [39] [40]. Structurally the northern part of Koh Sulaiman Tehsil represents (west to east) Rarkhan-Hinglun Burg Pusht-eastern Drug thrusted anticline, Barthi-Fazla Kach-Karkana syncline and Zinda Pir anticline trending N-S with low-moderate dips [39] [40], A long left lateral strike slip fault occurred at the western vicinity of Koh Sulaiman Tehsil area. This fault started from south of Rakhni, crossed Kingri town and ended on the west of Musakhel Bazar ([39] [40]. A major thrust fault namely Rarkhan-Hinglun Burg Pusht thrust is found in the western part of Koh Sulaiman Tehsil. The junction of above mentioned both faults occurred at the south of Rarkhan village.

Taunsa district represents significant petroleum deposits (being utilized) from Dhodhak area. Further Habib Rahi marl (condensate bearing) burn on fire is found in the Ghozeghar (Savi Ragha) area of Musakhel District (Balochistan) which is located in the northwestern vicinity of Chitarwata area of Taunsa District. So it is important for petroleum resources in Taunsa District. Based on exposed strata in Taunsa District and surrounding areas, the first interpreted petroleum reservoir level is Cenozoic strata like limestones of Pirkoh, Habib Rahi, Drug and Dungan formation while sandstone of Rakhi Gaj (Girdu Member). Drazinda, Domanda, Shaheed Ghat, Dungan and Rakhi Gaj (Bawata Member) shale act as source as well as cap-seal rocks. Second interpreted petroleum reservoir level is Late Cretaceous Mughalkot sandstone, Fort Munro limestone, Pab and Vitakri sandstones (Fort Munro Group). Mughalkot shale acts as source and cap. Third interpreted petroleum reservoir level is Early Cretaceous Parh Group consisting of Mekhtar sandstone (commonly called lower Goru sandstone), Goru marl/siltstone and Parh limestones. Sembar and Goru shales act as resource and cap rocks. Fourth interpreted petroleum reservoir level is Triassic-Jurassic Sulaiman Group like Wulgai (=Spingwar), Loralai and Chiltan limestones. Wulgai and Loralai shale act as resource and cap rocks.

Hot water-gas springs at Garmaf and Zinda Pir Ziarat localities, huge gypsum and cement raw materials (limestones, gypsum and clays/shale) deposits from Zinda Pir, Hikbai-Mubarki Top and Hinglun-Burg Pusht anticlines and alternating Barthi and Manjhail synclines, limestone and marl deposits from Drug, Habib

Rahi and Pirkoh formations, vast shale and clay deposits from Shaheed Ghat, Baska, Domanda and Drazinda formations and also in Chitarwata, Vihowa, Litra and Chaudhwan formations of Vihowa Group. Coal/carbonaceous shale from Mahoi, Zain, Chitarwata areas, ironstone showing in Oligocene Chitarwata Formation in Zain-Barthi and Chitarwata section, decorstone/marble from Dungan limestone and Rakhi Gaj fossiliferous sandstone from Zinda Pir Ziarat, north of Hikbai/Yakbai-Mubarki, Kharar, Pachadhi and Poadhi nalas of Manjhail, Sorra and Luni Kachiwanga areas, millstone and abrasives from Pab sandstone of Hikbai/Mubarki, Hinglun, Pachadhi nala of Pir Gahno, Burg Pusht and Luni areas, ochre showings in Vitakri, Drazinda, Chitarwata and Vihowa formations and others, celestite showings in Drug and Baska formations, gemstones and jewelry resources such as attractive detritial (pebbles and cobbles) and fragmentary chalcedonic silica (flint, chert and jasper) and others beautiful specimen, resistant and high density (heavy) minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and lithium bearing and other significant light minerals hosted in placer deposits of Oligocene to Pliocene Chitarwata, Vihowa, Litra and Chaudhwan Formations (Vihowa Group), and Pleistocene to Holocene Dada and Sakhi Sarwar Formations (Sakhi Sarwar Group) and Subrecent terrace and fan deposits and present river/stream/channel deposits, construction materials from Pab sandstones, Dungan limestones, Rakhi Gaj sandstone, Drug, Habib Rahi and Pirkoh limestones, gravels from conglomerate of Sakhi Sarwar and Vihowa Groups, and from alluvial terraces and fan deposits. Vast deposits of clays are found in Koh Sulaiman Range of Taunsa District. The fuller earth's clay is a significant commodity of Koh Sulaiman Range being exploited from Chamalang, Kahan and Vihowa Groups since a long. The uranium deposits/occurrences of Mahoi and north-south trending foot mountain belt of terrestrial fluvial rocks of Chitarwata, Vihowa, Litra and Chaudhwan Formations of Oligocene-Pliocene Vihowa Group are also significant for the development of Pakistan. Vast deposits of clays are found in Koh Sulaiman Range of Taunsa District. Sand from Indus River and its east west flowing tributaries, possible agrominerals like phosphatic nodules/shales and different clays like fuller earth, bentonite and fireclays from Chamalang, Kahan and Vihowa Groups were found. Different clays like fuller earth, bentonite, fireclays and aluminous clays especially from Mahoi, Zain, Sata Post and Baathi areas and surroundings. Constructions of smaller to medium sized dams are vital at different rudkohi/streams/nalas in Koh Sulaiman Range to storage water for agriculture and home use. Placer deposits need to be studied for resistant (to erosion) and high density (heavy) gold and other minerals (mentioned above) and also for significant light minerals. The uranium deposits, petroleum deposits (being used), interpreted different petroleum levels of Taunsa District are the best energy resources for the development of South Punjab and Pakistan. Development of tourism places at Fort Munro, Hikbai, Mubarki and Top Hinglun also play significant role for the development of area. Top Girdu and Mian Ghundi Khar areas of Taunsa District uncovered a few bones of dinosaurs and archosaurs. Other famous vertebrates from Taunsa district and surrounding areas were recently reported are walking whale *Rodhocetus kasrani* (protocetids cetacean whale evolved from artiodactyls) and swimming whale *Basilosaurus drazindai* and *Basiloterus husseini* basilosaurid (revealed early swimming of protocetids cetacean whale) from Rodho-Satta/Sata, swimming whales Basilosauridae *Sulaimanitherium dhanotri* from Zamri Drug, Rhinoceros largest land mammal *Buzdartherium,* crocodile *Asifcroco* from Gulki, and Proboscidean *Gomphotherium buzdari* from Mahoi. The excavation and development of these geological and mineral resources, construction of water dams and installation of cement and gypsum industry share a lot for the development of District and ultimately South Punjab.

Geology and Mineral Resources of Larkana District of Sindh: In Larkana District the bed rocks (Figure 1) existed at subsurface which is covered by recent and subrecent alluvial and eolian deposits in plain and subplain areas (cultivated and non-cultivated lands) which consist of exposed mixture of sand, silt and clays along with subordinate pebbles and cobbles. Indus River and sand dunes are the sources of sand for construction. Gold (on priority) and other resistant and heavy minerals like magnetite, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light minerals (which are significant) and lithium bearing minerals and gemstone and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others can be explored in Indus River recent sand and placer deposits. The cultivation and tree plantation on vast plain land can help for the sustainable development of the district. The subsurface folded Mesozoic and Cenozoic strata (Figure 1) may yield petroleum reservoirs. This district also hosts the famous Mohenjo Daro archeological site.

Geology and Mineral Resources of Qambar Shahdadkot District of Sindh: Qambar Shahdadkot District hosts in the eastern part the plain and subplain areas (cultivated and non-cultivated lands) which consist of mixture of sand, silt and clays along with subordinate pebbles and cobbles, while the western part is represented by mountain range called as Kirthar Range. The exposed Eocene to Holocene rocks (at subsurface the Mesozoic and Cenozoic strata may be found) are folded in the western part and found at subsurface in the eastern part (Figure 1). The folded Mesozoic and Cenozoic strata (Figure 1) in the eastern part may be found at subsurface and may yield petroleum reservoirs. Kirthar Range in this district host the construction materials (limestone, marl, shale, sandstone and conglomerate), cement raw materials (limestone, shale and gypsum), ironstone in the Oligocene Nari Formation, gypsum, celestite showing in Kirthar Formation and Gorag (Gorakh) Limestones. Resistant and high density (heavy) minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light lithium bearing and other significant minerals and gemstone and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others can be explored in placer deposits such as Miocene-Pliocene Manchar Group and Pleistocene-Holocene Sakhi Sarwar Group and also recent placer deposits in mountainous streams. The western part of district has many sites for smaller dam constructions for conservation of flood water (for domestic and agricultural purposes) because the eastern part of district has vast plain areas for cultivation. The cultivation and tree plantation on vast plain land found in eastern part of district area can help for the sustainable development of the district. The development of Kute the Qabar hill, Gorakh hill (of Kirthar Range) and other peaks for tourism may be an addition for the development.

Geology and Mineral Resources of Dadu District of Sindh: Dadu District hosts in the eastern and central parts the plain and subplain areas (cultivated and non-cultivated lands) which consist of mixture of sand, silt and clays along with subordinate pebbles and cobbles, while the western part is represented by mountain range called as Kirthar Range. The exposed Cretaceous to Holocene rocks (at subsurface the remaining Mesozoic strata may be found) are folded in the western part and found at subsurface in the eastern part (Figure 1). The exposed Cretaceous strata are only found at the Gorakh (Gorag hills) and surroundings with the boarder of Khuzdar Balochistan. The folded Mesozoic and Cenozoic strata (Figure 1) in the plain areas may be found at subsurface and may yield petroleum reservoirs. Kirthar Range in this district host the construction materials (limestone, marl, shale, sandstone and conglomerate), cement raw materials (limestone, shale and gypsum), ironstone in the Oligocene Nari Formation, gypsum, celestite showing in Kirthar Formation and Gorag (Gorakh) Limestones. Resistant and high density (heavy) minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light lithium bearing and other significant minerals and gemstone and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others can be explored in placer deposits such as Miocene-Pliocene Manchar Group and Pleistocene-Holocene Sakhi Sarwar Group (western range of Dadu district) and also recent placer deposits in mountainous streams and Indus River sands. The western part of district has many sites for smaller dam constructions for water resources (for domestic and agricultural purposes) because the eastern part of district has vast plain areas for cultivation. The cultivation and tree plantation on vast plain land found in eastern part of district area can help for the sustainable development of the district. Development of Gorakh hill and other peaks of Kirthar for tourism may be an addition for the development.

Geology and Mineral Resources of Jamshoro District of Sindh: The exposed Cretaceous to recent rocks (at subsurface the remaining Mesozoic strata may be found) are found in the western part and found at subsurface in the eastern part (Figure 1). The folded Mesozoic and Cenozoic strata (Figure 1) in the plain areas may be found at subsurface and may yield petroleum reservoirs. Lakhra anticline hosts significant 1328 million tons of coal deposits. Laki anticline (generally trending north-south) was named after Laki Shah Sadar Shrine located between the Amri and Sehwan on western bank of Indus River. Western and eastern flanks of Laki anticline represented by gentle to low and high/tight dips respectively. Ranikot (located in southern plunge of Laki anticline) is accessible from Sun village and adjoining gentle dome type Lakhra anticline is accessible from Khanot. The Maastrichtian (71 - 67 million years ago/Mya) terrestrial and sandstone (quartzose) of (thickness 150 m) of Pab Formation and overlying Latest Maastrichtian (67 - 66 Mya) continental fluvial red sandstone and shale (thick 35 m) Vitakri Formation were found as 3 discontinuous exposures in core axis of Laki anticline. Its dominant northern exposure in Bara-Khadro Nai/rudkohi section (3 km long with north to south trend) is accessible through Amri village on Indus Highway and yielded a referred tooth of mammal *Mirvitakriharan* [37]. Limb formations are Early Paleocene (Danian) Khadro (shale, limestone and sandstone), Early Paleocene Bara (Sandstone, shale, carbonaceous shale and coal) and late Paleocene Lakhra (mainly limestone with minor shale) formations of Ranikot Group. It followed by Eocene Laki Group which consists of Sohnari and Laki formations. Sohnari Formation comprised of shale (with ochre/laterite), limestone (yellowish brown), sandstone and coal, and correlated with Chamalang Group of Kirthar foldbelt (western) and Sulaiman basins. Laki Formation represented by three members which are limestones (thickness 45 m) of lower-Meting, shale (thickness 30 m) of middle-Meting and limestones (thickness 70 - 200 m) of upper-Laki members. The rubbly limestones of lower Meting and shale of middle Meting correlated with Kirthar-Formation of Kirthar-Group of western-Kirthar basin. The limestones of upper Laki correlated with prominent peak forming Gorag Formation of Kirthar Group of western-Kirthar basin. Geological formation namely Laki of lower Indus/Kirthar correlated with geological group namely Kahan of middle Indus/Sulaiman basin. Further followed by Oligocene Nari (marine ferruginous sandstone, shale and limestone) and Gaj (estuarine-marine and terrestrial shale, sandstone, gypsum and limestone) formations of Gaj Group, Miocene Litra (sandstone, conglomerate and shale), Pliocene Chaudhwan (shale, sandstone and conglomerate) formations of Manchar (coeval to Vihowa Group) Group, Pleistocene Dada (coeval to Urak; dominantly conglomerate with subordinate muds and sandstones) and Holocene Sakhi-Sarwar (shale, sandstone and minor conglomerate) formations of Sakhi Sarwar Group. The construction materials are common. The radioactive and heavy minerals (ilmenite, magnetite, gold, zircon, REEs bearing minerals monazite and xenotime, rutile, garnet and others), gemstones and jewelry resources like the chalcedonic silica, chert, flint, jasper, and other detritial beautiful gemstones and also light minerals (lithium and other significant element bearing) can be explored and exploited from Miocene-Recent placer and channel deposits. Celestite-aragonite was observed on the eastern flank. The western flank is significant for celestite deposits because close to Thono Bula Khan celestite deposits. The core exposures of fluvial Pab and Vitakri Formations suggest for detail paleontological exploration for eggs and bones of dinosaurs and associated vertebrates because of finding of coeval dinosaurs and other biota from Vitakri (central Pakistan) and eggs and bone fossils from Gujarat (western India).

Geology and Mineral Resources of Jhal Magsi District of Balochistan: Jhal Magsi District hosts in the eastern part the plain and subplain areas (cultivated and non-cultivated lands) which consist of mixture of sand, silt and clays along with subordinate pebbles and cobbles, while the western part is represented by mountain range called as Kirthar Range. The exposed Eocene to Holocene rocks (at subsurface the Mesozoic and Cenozoic strata may be found) are folded and rarely faulted in the western part and found at subsurface in the eastern part (Figure 1). The Mesozoic and Cenozoic strata (Figure 1) may yield petroleum reservoirs. Kirthar Range in this district host the construction materials (limestone, marl, shale, sandstone and conglomerate), cement raw materials (limestone, shale and possibly gypsum), ironstone in the Oligocene Nari Formation, gypsum, celestite showing in Kirthar Formation and Gorag (Gorakh) Limestones. Clays and ochers found in the area. Resistant and high density (heavy) minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light lithium bearing and other significant minerals can be explored in placer deposits such as Miocene-Pliocene Manchar Group and Pleistocene-Holocene Sakhi Sarwar Group and also recent placer deposits in mountainous streams. The western part of district has many sites for smaller dam constructions for water resources (for domestic and agricultural purposes) because the eastern part of district has vast plain areas for cultivation. The cultivation and tree plantation on vast plain land found in eastern part of district area can help for the sustainable development of the district. The cultural and heritage of Jhal Magsi district are Pir Chatal Shah Noorani oasis and shrine with its sacred fish filled ponds (pilgrimage for both Muslim and Hindus) located on the eastern foot mountain of Kirthar Range and near Kotra town, Taj Mahal of Balochistan (majestic mausoleum and architectural monument of Tomb in Moti Gohram) located 20 km from Gandawa, Pir Lakha shrine, Bhootani tomb and other tombs and shrines, and the extruding fan shaped mouth of Moola river are famous tourist places in Jhal Magsi District and needs their development.

Geology and Mineral Resources of Kachi District of Balochistan Province: Kachi District hosts in the south eastern part the plain and subplain areas (cultivated and non-cultivated lands) which consist of mixture of sand, silt and clays along with subordinate pebbles and cobbles, while the western part and northern parts are represented by mountain range called as Kirthar and Sulaiman Ranges. Very interesting is this Kachi District host the junction bend of Kirthar Range (lower Indus) and Sulaiman Range (middle Indus). The folded Mesozoic and Cenozoic strata are found exposed in the western and northern parts, while found at subsurface in the plain areas which are covered by alluvial and eolian deposits (Figure 1) may yield shallow and deep petroleum reservoirs in plain and hilly areas. Kirthar Range in this district host the famous Sani Shoran sulphur deposits, Mach-Abegum coal deposits (22.70 million tons), construction materials (limestone, marl, shale, sandstone and conglomerate), cement raw materials (limestone, shale and gypsum), ironstone in the Oligocene Nari Formation, celestite showing in Kirthar Formation and Gorag (Gorakh) Limestones. Resistant and high density (heavy) minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light lithium bearing and other significant minerals and gemstone and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others can be explored in placer deposits such as Oligocene-Pliocene Vihowa Group and Pleistocene-Holocene Sakhi Sarwar Group (northern range of Kachi district), Miocene-Pliocene Potwar Group and Pleistocene-Holocene Soan Group (western range of Kachi district) and also recent placer deposits in mountainous streams. Clays and ochers are found in the area. The western and northern part of district has many sites for smaller dam constructions for water resources (for domestic and agricultural purposes) because the southeastern part of district has vast plain areas for cultivation. The cultivation and tree plantation on vast plain land found in eastern part of district area can help for the sustainable development of the district. The cultural heritage of Kachi district is famous Mehar Garh archaeological site, Bolan Pass and Bibi Nani Ziarat.

Geology and Mineral Resources of Mastung District of Balochistan: Mastung District hosts mostly the mountain ranges with alternating valleys. Folded and faulted Mesozoic and Cenozoic strata are found exposed in the mountainous range while in plain areas covered by alluvial and eolian deposits (**Figure 1**). The folded Mesozoic and Cenozoic strata may yield petroleum reservoirs. Kirthar Range in this district hosts Rodangi coal (**Table 1**), Abe Gul coal, famous iron stone deposits (**Table 2**), fluorite deposits, construction materials (limestone, marl, shale, sandstone and conglomerate), cement raw materials (limestone, shale), ironstone in Nari Formation, celestite showing in Kirthar and Gorag Limestones, vast marble/dimension stones and numerous sites for dam construction to conserve flood water. Many significant calcite veins are also found in Jurassic Limestone especially on the peak of range just west of Khad Kucha. Johan-Dilband and Khad Kucha ironstones were initially discovered and samples collected by Malkani and Masud Tariq in 1990 [50] and their samples were analyzed by Chemistry Laboratory, Geological Survey of Pakistan, Quetta which results (**Table 2**) show 24.79% to 69.75% Fe_2O_3 of Johan-Dilband and 24.79% Fe_2O_3 of Khad Kucha ironstone [8] [9]. Later on detail survey was carried out by Akhtar Kakepoto and Mian Hassan Ahmad. Further Akhtar Kakepoto and M. Sadiq Malkani also worked on Johan-Dilband ironstones and their extension which resulted in increase of reserves [8]. Most of the ironstone deposits are found in Mastung District (Dilband-Johan deposits and Khad Kucha lense shaped ironstone), however some lense shaped occurrences are under Kachi, Kalat, Khuzdar and Quetta districts. In the southern part of Marav river area, in the subsurface ironstone occurred in Kalat District and Regwash exposed iron body in Kalat district. The ironstone lenses in the east of Noor Gamma Zahri (Khuzdar District), vicinity of Coalpur area (Kachi District), Murdar Ghar foothills (Quetta District) were found. Rodangi coal found 10 km toward north of Zard Ghulam Jan and fall under Mastung district.

Table 1. Chemical analyses of Rodangi coal and carbonaceous shale of Paleocene age. Samples collected by Masud Tariq and M. Sadiq Malkani (Geologists) during field 1990-91 under Geological mapping and mineral investigation project [50]. These samples were chemically analyzed by M. Akbar Niazi, Chemist, approved by S.M. Habibullah, Senior Chemist, Geological Survey of Pakistan (Southern Division), F-11, Block F, North Nazimabad, Karachi conveyed via Chemical Lab no. 4491, Job No. 353 and Chemical analysis Report No. GSP/SD/Chem (91-92) 5 dated November 3, 1991.

Sample No.	Analyses	Moisture %	Volatile matter %	Ash %	Fixed Carbon %
MS/RC-1 Sp. Gravity (Apt) is 2.39 Heating value (BTU/LB) is below detection limit	As received	2.80	09.71	83.40	04.09
	Dry basis	-	09.99	85.80	04.21
	Dry ash free basis	-	70.36	-	29.64
MS/RC-2 Sp. Gravity (Apt) is 2.37 Heating value (BTU/LB) is below detection limit	As received	2.54	10.69	83.57	03.20
	Dry basis	-	10.97	85.75	03.28
	Dry ash free basis	-	76.96	-	23.04
MS/RC-3 Sp. Gravity (Apt) is 2.53 Heating value (BTU/LB) is below detection limit	As received	2.70	09.57	86.82	00.91
	Dry basis	-	09.83	89.23	00.94
	Dry ash free basis	-	91.32	-	08.68
MS/RC-4 Sp. Gravity (Apt) is 2.49 Heating value (BTU/LB) is below detection limit	As received	2.59	10.31	85.56	1.54
	Dry basis	-	10.58	87.84	1.58
	Dry ash free basis	-	87.01	-	12.99
MS/RC-5 Sp. Gravity (Apt) is 2.58 Heating value (BTU/LB) is below detection limit	As received	0.64	10.43	60.07	19.86
	Dry basis	-	10.50	69.51	19.99
	Dry ash free basis	-	54.43	-	65.57

Table 2. Chemical analyses of Khad Kucha and Johan-Dilband ironstone samples collected by Masud Tariq and M. Sadiq Malkani (Geologists) during field 1990-91 under Geological mapping and mineral investigation project [50]. These samples were chemically analyzed by Allah Bukhsh, Chemist, approved by Mushtaq Hussain, Chief Chemist, of Geological Survey of Pakistan, Sariab road, Quetta, conveyed via Chemical analysis Report No. Chem (91-92) 10 dated January 16, 1991. This table is after [8] [9].

Lab No.	Sample No.	Locality	Fe_2O_3%	CaO%	SO_3%	P_2O_5%	TiO_2%	Pb%	Zn ppm
1981(8)	MS-36	North of Johan town and Southwestern part of Dilband Range (Kalat)	56.01	5.70	0.00	-	-	-	-
1981 (9)	MS-37	North of Johan town and Southwestern part of Dilband Range (Kalat)	69.66	-	-	0.20	0.32	0.00	291
1981(14)	MS-37 (D)	North of Johan town and Southwestern part of Dilband Range (Kalat)	69.75	-	-	0.20	0.32	0.00	291
1981(13)	MS-44	Khad Kucha Range, east of Tehsil offices of Khad Kucha (Kalat)	24.79	0.41	0.00	-	-	0.00	235

Geology and Mineral Resources of Lasbela District of Balochistan: Lasbela district hosts sedimentary, igneous and metamorphic rocks of Mesozoic and Cenozoic era (**Figure 1**). Lasbela district is situated on western Indus suture, western Kirthar foldbelt (lower Indus basin) and southeastern corner of Makran Range

(Balochistan basin). Western Indus suture (ophiolite; [51]) is a contact between Indus basin (part of Indo-Pakistan subcontinental plate which is a fragment of Gondwana) in the east and Balochistan basin (part of Arabian Sea plate and Tethys) in the west. Structurally the area is folded and faulted, generally trending north south. The central and eastern parts of Lasbela district represent the stratigraphy of Kirthar basin (**Figure 1**), while the western part of Lasbela District area west of western Indus suture comprised of Late Eocene to Oligocene Makran Group (Hoshab shale and Panjgur sandstone and shale); Late Miocene to Early Pliocene Talar Group (Parkini mudstones, Talar terrestrial sandstones important for exploration of land vertebrates and fauna and Chatti mudstones); Pleistocene-Holocene Kech Group represents the Pleistocene Kech conglomerate and Holocene Jiwani shelly Limestone, Subrecent and Recent Makran mud volcanoes, alluvium and eolian deposits [3] [4] [7]. Lasbela district host many significant metallic and non metallic minerals like lead, zinc and mercury from Duddar area (Southeast of Lasbela city) hosted in upper part of Jurassic Shirinab/Anjira/Loralai limestones and shales; chromite, asbestos, magnesite, manganese, barite, iron, (possible platinum group elements), gemstones (quartz, chert, jasper, flint and others) and construction stones from Bela ophiolitic complex situated in northern part of Lasbela district; copper from Ann Dhoro and Paha Dhoro areas; Paleocene coal from Dureji area; iron (in Nari Formation), cement materials, construction stones, gypsum, manganese, diversified clays, fluorite (from Jurassic limestones) and celestite (from Eocene Kirthar limestone and shale) in eastern ranges of Lasbela district, and salt along coastline, and heavy and resistant minerals possibly zircon, gold, rutile, garnet, magnetite, ilmenite, monazite and Xenotime REEs bearing, sillimanite and others in coast shore line sand and placers. Cement raw materials such as limestones and clays as are also common (which appeal for installation of cement industry) except gypsum which may be needed from Gaj areas (Kirthar foldbelt, Sindh), eastern Balochistan province and western south Punjab (Koh Sulaiman Range) areas. Negligible gas concentration is reported in the extrusion of mud volcanoes in southeastern Makran Range. Besides these metallic and non metallic minerals, the petroleum exploration and prospecting in eastern ranges of Lasbela district is significant. Lasbela districts host both surface and ground water, but most of surface water wasted as flood, which needs construction of small to medium sized dams for water storage, and excavation and development of mineral and rock resources are vital for the development of district and his population.

Geology and Mineral Resources of Tank District of KP Province: Tank District hosts in the south and eastern parts the plain and subplain areas (cultivated and non-cultivated lands) which consist of mixture of sand, silt and clays along with subordinate pebbles and cobbles, while the western part is represented by mountain range called as Sulaiman Range and northern part by mountain range which is extension of Sheikh Budin hills and Khisor Range. Tank district hosts the junction bend of lower Indus (Sulaiman basin) and upper Indus (Kohat-Potwar-

Kotli basin). The exposed Cenozoic strata found in the mountainous parts, while Mesozoic and Paleozoic rocks may be found at subsurface in the plain areas which are covered by alluvial and eolian deposits (Figure 1). The Mesozoic and Cenozoic strata (Figure 1) may yield petroleum reservoirs. The rocks such as sandstone, shale, limestone and conglomerate may be used for construction materials. Clays and ochers found in the area. Small gypsum deposits are expected. The radioactive minerals, resistant and heavy minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light lithium bearing and other significant minerals and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others can be explored in placer deposits such as Oligocene-Pliocene Vihowa Group and Pleistocene-Holocene Sakhi Sarwar Group (western range of Tank district), Miocene-Pliocene Potwar Group and Pleistocene-Holocene Soan Group (northern range of Tank district) and also recent placer deposits in mountainous streams. The western and northern hilly areas of district has many sites for smaller dam constructions for water resources (for domestic and agricultural purposes) because the eastern and south eastern part of district has vast plain areas for cultivation and tree plantation which can help for sustainable development of district.

Geology and Mineral Resources of Bannu District of KP: Bannu District hosts in the eastern and central parts the plain and subplain areas (cultivated and non-cultivated lands) which consist of mixture of sand, silt and clays along with subordinate pebbles and cobbles, while the southern, western and some northern parts are represented by mountain ranges. The exposed Cenozoic strata (and subsurface Mesozoic and probably older rocks) are found in the mountainous parts, while eisted at subsurface in the plain areas which are covered by alluvial and eolian deposits (Figure 1). The Mesozoic and Cenozoic strata (Figure 1) may yield petroleum reservoir. The rocks such as sandstone, shale and limestone are common and may be used for construction materials. Clays and ochers are found in the area. The radioactive minerals and resistant and heavy minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light lithium bearing and other significant minerals and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others can be explored in placer deposits such as Oligocene-Pliocene Vihowa Group and Pleistocene-Holocene Sakhi Sarwar Group (western range of Bannu district), Miocene-Pliocene Potwar Group and Pleistocene-Holocene Soan Group (northern and southern ranges of Bannu district) and also recent placer deposits in mountainous streams. The area has many sites for smaller dam constructions for water resources (for domestic and agricultural purposes) because the eastern part of district has vast plain areas for cultivation. The cultivation and tree plantation on vast plain land found in eastern part of district area can help for the sustainable development of the district

Geology and Mineral Resources of Laki Marawat District of KP: Laki Marawat District hosts in the north and central parts the plain and subplain areas (cultivated and non-cultivated lands) which consist of mixture of sand, silt and clays along with subordinate pebbles and cobbles, while the south eastern, eastern and southern parts are represented by mountain ranges. The exposed Cenozoic strata found in the mountainous parts, while Mesozoic and Paleozoic rocks may be found at subsurface in the plain areas which are covered by alluvial and eolian deposits (**Figure 1**). The folded Mesozoic and Cenozoic strata (**Figure 1**) may yield shallow petroleum reservoirs. Possible subsurface coal just south of Makarwal shows subsurface occurrence of coal in the eastern area of district. Petroleum Coal tar seep of Kundal and northern vicinity proven petroleum reservoir provide good hopes for subsurface petroleum resources. The rocks such as sandstone, shale and conglomerate are common and may be used for construction materials. Clays and ochers found in the area. The radioactive minerals,and heavy minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light lithium bearing and other significant minerals and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others can be explored in placer deposits such as Miocene-Pliocene Potwar Group and Pleistocene-Holocene Soan Group and also recent placer deposits in mountainous streams and Indus river. There are many sites for smaller dam constructions for water resources (for domestic and agricultural purposes) because the district hosts vast plain areas for cultivation and tree plantation which can help for the sustainable development of the district.

Geology and Mineral Resources of Karak District of KP: Karak District hosts in the southern and central parts the plain and subplain areas (cultivated and non-cultivated lands) which consist of mixture of sand, silt and clays along with subordinate pebbles and cobbles, while the northern and eastern parts are represented by mountain ranges. The exposed Cenozoic strata are found in the mountainous parts, while Mesozoic and Paleozoic rocks may be found at subsurface in the plain areas which are covered by alluvial and eolian deposits (**Figure 1**) which may yield petroleum reservoirs (hope from neighboring reservoirs). The rocks such as limestone, marl, sandstone and shale are common and may be used for construction materials. Clays and ochers are found in the area. Large gypsum deposits and salt (Halite) deposits are found in the northern part. Cement Industry raw materials (limestone, gypsum and shale) found encourage the installation of cement industry. Subsurface coal just west of Makarwal may be existed but its mining will be problem. The radioactive minerals, and heavy minerals like magnetite, gold, ilmenite, sheelite, garnet, rutile, zircon, sillimanite, REEs bearing minerals monazite and xenotime, and light lithium bearing and other significant minerals and jewelry resources such as attractive detritial (pebbles and cobbles), chalcedonic silica (jasper, flint, chert) and others can be explored in placer deposits such as Miocene-Pliocene Potwar Group and Pleistocene-Holocene Soan Group and also recent placer deposits in streams. There are many sites for smaller dam constructions for water resources (for domestic and agricultural purposes) because the district has vast plain areas for cultivation and tree plantation which can help for the sustainable development of the district.

3.2. Recently Found Paleontological Sites from Pakistan

Recent paleontological exploration uncovered more than 50 localities. Here these localities and discovered fauna from Paleozoic, Mesozoic and Cenozoic marine and terrestrial strata is being presented. The locality name commonly followed here by locality number. From many localities the bone assemblage and rarely isolated bones were collected (in some cases only observed and not collected) on surface from the latest Maastrichtian Vitakri Formation of Fort Munro Group. Dr. David W. Krause suggested (on visit to Vitakri) to name Malkani Formation (now Vitakri Formation, see below) this archosaur host beds because these are terrestrial sediments while Pab Formation is marine. Many localities host the geological Formations (other than Vitakri Formation) which are being mentioned in following description.

Vitakri dome area localities (Barkhan District, Balochistan)

The localities in the Vitakri dome area are called by local people generally as Kali Kakor. Following division and names are adapted for specific stream and localities.

Sangiali 1 (Pakistan Dinosaur Locality PDL-1): Sangiali locality is named after Sangiali stream located just near the Sangiali village. Sangiali stream flows south to north. It is divided into lower/north Sangiali, mid Sangiali and upper/south Sangiali. The lower Sangiali (north Sangiali) yielded *Imrankhanhero zilefatmi* titanosaur holotypic and type series fossils. The mid/middle Sangiali uncovered *Qaikshaheen masoomniazi* titanosaur holotypic assemblage and referred vertebrae of *Vitakridrinda sulaimani* theropod. The upper Sangiali/south Sangiali yielded *Ikqaumishan smqureshi* titanosaur holotypic and type series fossils which consists a simple thin armor plate (estimated about 5 cm in diameter and 1 cm in depth GSP-BC-001/01 with Dr David Krause of Boston College (then in 2001), USA for preparation), caudal vertebrae and limb bones.

Bor 2: Bor 2 is named after Bor stream located just eastern front of Vitakri village. Bor stream flows east to west. Lower Bor/west Bor yielded holotype of *Khanazeem saraikistani* titanosaur, middle Bor uncovered holotype of *Vitakrisaurus saraiki* theropod and referred fossil assemblage of *Qaikshaheen masoomniazi* titanosaur, and upper Bor/east Bor yielded referred tibia of *Gspsaurus pakistani* titanosaur.

Shalghara 3: Shalghara locality is named after a small hill which includes broken and disturbed large boulders. Shalghara stream flows north to south. This locality yielded holotype of *Shansaraiki insafi* theropod and *Mithasaraikistan ikniazi* crocodile and referred bone of *Pabwehshi pakistanensis* crocodile. This locality yielded crocodilian articulated 3 vertebrae GSP-BC-002/03 and a femur/humerus GSP-BC-003/03 which are with Dr David Krause of Boston College (then in 2001), USA for preparation may possibly belong to *Mithasaraikistan ikniazi*.

Kinwa stream hosts 4/4s. 4m, 4n and 16 localities: Kinwa stream is named after Water gas spring at the outer exit of stream. Kinwa stream flows east to west upper part and northeast to southwest lower part. Kinwa stream is divided into south Kinwa 4/4s, southwestern Kinwa 4/4s, mid Kinwa 4m, north Kinwa 4n and east Kinwa (Top Kinwa 16). The south Kinwa 4 or 4s (which hosts many sites) yielded holotype of *Sulaimanisaurus gingerichi* (southernmost site), *Saraikimasoom vitakri* (just west of Kinwa stream and south of hill peak) and *Pakisaurus balochistani* (southwestern site near the shortest track of Vitakri village to Kinwa spring) titanosaurs and referred bones of *Gspsaurus pakistani* titanosaur and holotype of *Sulaimanisuchus kinwai* crocodile (northern side of hill peak located just west of Kinwa water spring). The mid Kinwa 4m yielded holotype of *Khetranisaurus barkhani* and referred bones especially vertebrae and femur of *Qaikshaheen masoomniazi*. The south Kinwa and mid Kinwa yielded referred bone of *Ikqaumishan smqureshi*. The type locality of *Pakisaurus balochistani* also uncovered partial skull roof (parietal). The north Kinwa 4n yielded holotype of *Nicksaurus razashahi* titanosaur. The east Kinwa/top Kinwa hosts 3 or more than 3 sites. The easternmost site yielded holotype of *Imrankhanshaheen masoombushrai* titanosaur, *Saraikisaurus minhui* noasaurid theropod and *Pabwehshi pakistanensis* crocodile. Western site of Topkinwa yielded referred bones of *Khanazeem saraikistani* titanosaur. Northern sites of Topkinwa yielded referred bones of *Ikqaumishan smqureshi* titanosaur.

Dada Pahi 17: Dada Pahi locality 17 hosts a referred osteoderm of *Ikqaumishan smqureshi* titanosaur and many bones were observed (not collected).

Alam Localities 18, 19: East Alam 18 hosts a few referred assemblages of *Ikqaumishan smqureshi* and other titanosaurs and these bones were only observed (not collected). Alam locality 19 is subdivided into north Alam 19n, central Alam 19/19c and south Alam 19s. North Alam 19n yielded the referred bones of *Pakisaurus balochistani* titanosaur, the central Alam 19/19c yielded holotypes of *Gspsaurus pakistani* titanosaur, *Vitakridrinda sulaimani* theropod, *Induszalim bala* crocodile, *Wasaibpanchi damani* bird and *Wadanaang kohsulaimani* snake, and south Alam 19s yielded few titanosaur bones just few meter below the southernmost peak.

Rosmani 20: This locality yielded a few titanosaurian bones.

Dhaola Range localities (Gambrak-Nahar Kot area of Barkhan, Balochistan)

The northern or northwestern slope of Dhaola Range hosts 5 - 13 localities. All the localities (5 - 13) were traversed east to west by up and down traversing due to ridges and stream cut/bed. All these localities fall under the Gambrak area of Naharkot. Gambrak area has disseminated population clusters and isolated homes or jhompries. Naharkot town is a market for population of surrounding mountain ranges especially for Khetran, Mari and Bugti tribes. Dhaola Range westward merge into Andari Range and eastward merge into Mazara-Badhi Range.

Dagar 5: Dagar 5 is located possibly about 0.5 - 1 km in the east of Goeswanga 6 and yielded titanosaurian fan shaped distal scapula with rugosities on dorsal profile.

Goeswanga 6: Goes Wanga pass locality 6 occurred at N 29˚43'35"; E 69˚30'59" and yielded a wood fossil of large tree found from the Dhaola member of Maastrichtian Pab Formation.

Zubra 7: Zubra peak 7 occurred at N 29˚42'43"; E 69˚29'53" and south Zubra/Basti nala 7 is situated about 100 - 150 m west of Zubra peak locality. Zubra peak and south Zubra yielded referred bones of *Imrankhanhero zilefatmi*.

Darwaza 8: Darwaza locality 8 occurred further west southwest of south Zubra locality and yielded referred fossils of *Marisaurus jeffi*.

Grut 9: Grut 9 occurred at N 29˚42'34"; E 69˚29'29" and yielded referred bone assemblage of *Akimrantitan waqarzaki* new genus and new species of titanosaur.

Rahiwali 10: Rahiwali 10 occurred at N 29˚42'19"; E 69˚29'08" and yielded holotype of *Akimrantitan waqarzaki* new genus and new species of titanosaur.

Dolwahi northeast 11: It was found just west of Rahiwali 10. This locality yielded referred fossils of *Akimrantitan waqarzaki* new titanosaur.

Dolwahi east-northeast 12: This was found just west of north Dolwahi 11 and yielded referred fossils of *Akimrantitan waqarzaki* new titanosaur.

Dolwahi east 13: This was found west of locality 12 and yielded referred fossil of *Akimrantitan waqarzaki* new titanosaur.

Andari Range localities (Barkhan District, Balochistan)

The northwestern slope of Andari Range consists of Sidiqani-Chappar locality 14, which yielded few bones of archosaur.

Fazil Chil -Mari Kachi Range (Barkhan District, Balochistan)

Mari Kachi/Mari Bohri 15: Eastern plunge of Mari Kachi-southern Fazil Chil anticline consists of Mari Bohri 15. Northern 2 sites yielded *Marisaurus jeffi* holotype and southern 3 sites yielded *Balochisaurus malkani* holotype and referred bones.

Pikal Range localities (Barkhan, Kohlu and Dera Bugti Districts, Balochistan)

The northwestern part of northern slope of Pikal Range hosts Kachar-Jhabar locality 23 (boarder of Barkhan and Kohlu districts) and also northern part of southern slope of Pikal Range host Mat Khetran locality 21 (Barkhan District) and southern part of southeastern slope Bhal locality 22 (Beaker area of Dera Bugti District). These localities yielded a few vertebrae and limb bone sections of titanosaurs.

Koh Sulaiman Tehsil of Taunsa District localities (South Punjab)

The localities 24 to 27 fall under the territory of Koh Sulaiman Tehsil of Taunsa District of South Punjab. The localities 28 to 31 fall under the territory of Jampur Tehsil of Rajanpur District of South Punjab. Fort Munro-Maarri anticline was visited to see the occurrence of Vitakri Formation which can be used for further exploration.

Top Girdu 24: This locality is found on the top of Girdu section. There is disturbed brown shale and sandstone of Vitakri Formation. A bone section of may be dinosaur was found on few minutes visit near eastern bend of uppermost part of road east of Khar. This locality is under the territory of Koh Sulaiman Tehsil of Taunsa District of South Punjab.

Khar Fort Munro 25: This locality is found on the eastern side of northeastern plunge (north of road and hotel) of Mian Ghundi anticline. A bone of archosaur was found on the surface of the Vitakri Formation. This locality is under the territory of Koh Sulaiman Tehsil of Taunsa District of South Punjab.

Rakhi Gaj 26: This locality is found on the south of road, one kilometer from the Rakhi Gaj post. Here the maroon shale is dominant. According to Dr. David Krause on his visit, this maroon shale is marine. On my visits I did not found any large bone of dinosaurs but strata is fit into Vitakri Formation.

Shadiani 27: This locality is found on the Fort Munro anticline on the south of Hikbai top peak. Here at the core the Lower Cretaceous Parh Limestone is exposed. On the western limb a few meters laterite of Vitakri Formation was found.

Mahoi 35: This locality is found on the eastern limb of Zinda Pir anticline. This locality yielded Gomphotherium buzdari a proboscidean from Miocene Litra Formation. Many bones are also observed in Chitarwata Formation.

Gulki 36: This locality is found on the eastern limb of Zinda Pir anticline. This locality yielded Buzdartherium gulkirao large rhinoceros/Paraceratherium and terrestrial crocodile Asifcroco retrai. These taxa are found from Oligocene Chitarwata Formation. Many bones are also observed in terrestrial beds of Vihowa Group.

Gurben Sakhi Sarwar: This locality yielded bear bones [52] and *Sakhibaghoon khizari* [40] gavial crocodile from upper Miocene Litra Formation of Vihowa Group.

Baathi and Shamtala: This locality is expected to yield Eocene to Pleistocene marine and terrestrial fauna

Musakhel District Locality of Balochistan

Zamri 37: This locality is found on the eastern limb of Shin Ghar anticline and yielded a swimming basal whale *Sulaimanitherium dhanotri* large basilosaurid and many larger gastropods (20 - 30 cm long) found from Middle Eocene Drazinda Shale.

Jampur Tehsil of Rajanpur District Localities (South Punjab)

Chitri 28: This locality is found 25 - 30 km on the south of Fort Munro town. At the Chitri area on the eastern limb the Vitakri Formation occurrences are found.

Dragal 29: This locality is found on the south of Chitri and on the north of Maarri peak. Here the Vitakri Formation is not preserved and Pab Sandstone is exposed.

Maarri peak 30: This locality is found on the southern plunge of Fort Munro anticline. Here Vitakri formation is not well preserved. The Maastrichtian Pab Formation and Paleocene Rakhi Gaj and Dungan Formations are well exposed. A footprint of small sauropod (*Dgkhansauroperus maarri*) may be titanosaur was reported from the Pab Sandstone.

Kaha-Harrand 31: This yielded a fish fossil from the Maastrichtian Pab Sandstone.

Dera Bugti District localities (Balochistan)

Bhal Locality 22 is dinosaur locality also described above.

Siah Koh Locality 31: This locality yielded Arthropoda *Nisaukankoil beakeri* and *Phailawaghkankoil derabugti* from Early Paleocene Rakhi Gaj Formation.

Zin and Bhambhore Ranges: Zin anticline is located just south of Dera Bugti town and also south of Dera Bugti syncline. The northern limb of Dera Bugti syncline overlaps with the Pirkoh anticline. This northern limb of Dera Bugti district is called Bhambhore Range. The Vihowa Group of Dera Bugti syncline yielded famous vertebrate especially largest land mammals.

Barkhan-Kohlu District localities

Kachi Bohri-Mawand Range 33: This range consists of well exposures of Pab and Mughal Kot sandstone and shale starting from Jandran-Kachi Bohri and north of Mawand. However on the eastern plunge at Kachi Bohri where much literature mentioned Kohlu volcanics at Ber locality. Actually these are tectonically extrusive clasts derived mostly from Vitakri Formation. Like this a small heap or hill consisting of disturbed clasts and boulders are found at Shalghara locality in Vitakri dome.

Jandran Range 34: This range consists of well exposures of Pab and Mughal Kot sandstone and shale starting from Jandran-Kachi Bohri and north of Mawand. However on the eastern plunge at Kachi Bohri where much literature mentioned Kohlu volcanics at Ber locality. Actually these are tectonically extrusive clasts derived mostly from Vitakri Formation. Like this a small heap or mond or hill consisting of disturbed clasts and boulders are found at Shalghara locality in Vitakri dome.

Harnai District Locality

Gochina Harnai Locality: This locality yielded flood (rich) of nummulites, assilina, alveolina and other foraminifers and some bivalves hosted by Kahan Group limestones on the south of Gochina village which is also located south of Harnai town.

Locality of Loralai District

Kasa synclinal core Locality: This locality yielded large gastropods (20 – 30 cm long) among other foraminifer's fossils.

Khuzdar District localities

Sun Chaku Locality 38: This locality is found on west of Sun Chaku village. The host Formation is lower Sembar shale with minor marl with Late Jurassic-Early Cretaceous age. This is the type locality of *Brohisaurus kirthari* an ankylosaur.

Charo Locality 39: This locality yielded a referred bone of *Brohisaurus kirthari* an ankylosaur hosted by Late Jurassic lower Sembar shale and minor marl.

South Karkh Locality 40: This locality yielded fragmentary fish fossils may be derived from Early Paleocene Rakhi Gaj beds or Maastrichtian Vitakri and Pab Formations and dinosaur fossil may be derived from Maastrichtian Vitakri Formation.

East Karkh (Pir Bari road) Locality 41: This locality yielded an egg from Maastrichtian strata and *Pakiwheel karkhi* nautiloid from the volcanic or volcaniclastic beds of Early Paleocene Rakhi Gaj Formation.

Southeast Kharzan (Kharzan-Karkh road) Locality 42: This locality yielded star fish echinoid (*Mulastar*) invertebrate found from Early Eocene Shaheed Ghat shale.

North Kharzan Locality 43: This locality yielded *Pakiring kharzani* pelecypod invertebrate from lateritic rust of Vitakri Formation coated on Pab sandstone.

Kil Locality 44: This locality yielded a trilobite invertebrate *Moolatrilo chotoki* found from the Jurassic (May be Permo-Triassic) Chiltan Limestone.

Chotok Locality 45: This locality yielded a plesiosaur *Zahrisaurus kilmoolai* found from the Jurassic Chiltan Limestone.

Madan-Jhukur Locality 46: This locality yielded a small pes of sauropod (*Chiltansauroperus*) found from the upper part of Jurassic Chiltan Limestone.

Khuzdar Locality 47: This locality yielded a rib of marine crocodile *Khuzdarcroco zahri* from the maroon beds of Early Cretaceous Goru Formation.

Kachi District locality

Western Mach Locality: The coal mining at this locality yielded *Bolanicyon shahani* mammal from Early Eocene terrestrial Toi Formation.

Locality of Muzaffarabad Area, Azad Kashmir, Pakistan

Muzaffarabad locality: Extremely ancient living creatures especially vertebrates from Pakistan discovered are Cambrian (541 - 485.4 million years ago) fish from Abbottabad dolomite and limestone found at Cambrian explosion time.

Locality of Jamshoro District, Sindh

Bara area of Laki Range: Stream sediments from Bara area (source from Vitakri and Pab Formations) of Laki anticline yielded a tooth of mammal *Mirvitakriharan*.

Locality of Kohat District, Khyber Pakhtunkhwa

Kohat Development Authority (KDA) Locality: A diplodocid dinosaur **(***Safisaur niazensis* new genus and new species, see below) discovered from possibly middle Jurassic (upper red/marron member) Shinawari Formation of Kohat Development Authority locality of Kohat area, Khyber Pakhtunkhwa.

3.3. New Titanosaur with Some Updates on Titanosaurs from Pakistan

Systematic paleontology of new titanosaur

Dinosauria; Saurischia; Sauropoda; Titanosauriformes; Titanosauria; Poripuchia [34] vide [36]; Gspsauridae [29] vide [36];

Akimrantitan waqarzaki new genus and new species (**Figure 3**)

Holotype: Partial humerus GSP/MSM-237-10 including proximal and mid portions (**Figure 3**) belongs to a single individual. Holotype was recovered after partial excavation because it was partially exposed and partially embedded in host rocks. Fossil is housed in the museum of Geological Survey of Pakistan, Quetta, Pakistan.

Figure 3. *Akimrantitan waqarzaki* new genus and new species holotype (first two photos/p of row 1) and referred specimens (last two photos of row 1 and complete rows 2 and 3). **Row 1**, p1, 2, holotypic partial left humerus GSP/MSM-237-10 from Rahiwali type locality in anterior and posterior views; p3,4, referred stocky distal right tibia GSP/MSM-75-9 from Grut in 2 views. **Row 2**, p1-4, caudal vertebra GSP/MSM-52-9 in 4 views (scale bar 5 centimeter/cm; for precise scale see Figures 9-12 of [16]) from Grut; p5, caudal vertebra GSP/MSM-526-9 (mistyped as GSP/MSM-793-9 in following reports (Figure 9, row 1 of [33]; Figure 6, row 4 and page 429 of [37]; Table 2, column 3 of [41]; Table 2, column 2 of [8]; Figure 12, row 2 and table 8, column 4 and also on page 480 of [9]) from Grut. **Row 3**, p1, right astragalus GSP/MSM-752-9 (scale bar 10 cm; for precise scale see Figure 7 of [22]); transverse length 15 cm, anteroposterior width 10 cm); p2, distal ulna GSP/MSM-252-9 (scale bar 10 cm; for precise scale see Figure 7 of [22]); p3, proximal humerus with prominent head (mosaic of samples GSP/MSM-694-9 and GSP/MSM-759-9) from Grut locality; p4, proximal thoracic rib GSP/MSM-321-13 from East Dolwahi (scale bar 10 cm, for precise scale see Figure 4 of [23]). Scale, each black or white digit is 1 cm.

Referred Fossils: Bone assemblage from Grut locality 9 (PDL 9) represented by caudal vertebrae GSP/MSM-52-9 and GSP/MSM-526-9, right tibia GSP/MSM-75-9, right astragalus GSP/MSM-752-9 (transverse length 15 cm, anteroposterior width 10 cm), distal ulna GSP/MSM-252-9, proximal humerus with prominent head (mosaic of samples GSP/MSM-694-9 and GSP/MSM-759-9) (**Figure 3**) is being referred to *Akimrantitan waqarzaki* based on nearby findings and partial overlap of proximal humerus and size agreement. It is possible the assemblage from Grut may belongs to holotypic individual or both may belong to one species due to size agreements, nearby findings and no duplicate bones except proximal humeri which may be left and right limbs. A distal humerus GSP/MSM-236-11 (observed on the western side of small hill peak and entered in locality 11), proximal part of ulna GSP/MSM-919-11 and a few section/part of bones GSP/MSM-561-11, GSP/MSM-562-11, GSP/MSM-563-11, GSP/MSM-758-11 and GSP/MSM-920-11 from north-east Dolwahi (Dolvahi) locality PDL 11, a few bones from east-northeast Dolwahi locality 12, and a proximal thoracic rib GSP/MSM-321-13 from East Dolwahi PDL 13 are being referred to *Akimrantitan waqarzaki* based on nearby findings. It is also possible the bones from locality 11 may belong to holotypic individual or may belong to one species. Referred fossil from Pakistan are housed in the museum of Geological Survey of Pakistan, Quetta, Pakistan. From India a robust transversely expanded distal tibia K27/508, left metatarsal K27/509 and left ischium K27/510 from Pisdura, west of Dongargaon (Figures 1, 2, 3 of Plate VII of [53]) are being referred to *Akimrantitan waqarzaki* based on overlapping of robust tibia with small astragalous fossa situated in front of short process. Further caudal vertebra K27/501 from Pisdura India (Figure 1 of Plate VIII of [53]) is being referred due to moderately reduced ventral view than dorsal view.

Type locality, horizon and age: Holotype was found in the Rahiwali (Rahi Wali) locality (Figure 1 of [37]) (Pakistan dinosaur locality/PDL 10) with grid reference N 29˚42'19''; E 69˚29'08'', Gambrak-Nahar Kot area, Dhaola Range, Barkhan District, Balochistan Province, Pakistan. Host horizon and stratigraphic position of holotype and referred fossils is the upper shale unit caped by upper sandstone unit of Vitakri Formation (Table 1 of [38]) of Fort Munro Group [3] [4]. Vitakri Formation is embedded between the previously well dated Maastrichtian Pab Formation (lower formation) and well dated Paleocene formations (upper formations), according to stratigraphic position the age of Vitakri Formation was considered Late Cretaceous, more specifically latest Maastrichtian 67 - 66 Ma ([41] pages 903-906; [19] [22] [36] [37]).

Etymology: *Akimrantitan*, in honor of Aleema Khan (sister of Imran Khan), Alia Hamza Malik and Hamad Azhar (*A*), Kasim Khan and Sulaiman Isa Khan (*k*) (both son of Imran Ahmad Khan Niazi Former prime minister of Pakistan) whose efforts under supervision of Imran Ahmad Khan Niazi (*imran*) former Prime Minister of Pakistan achieved more than 6% growth rate for the development of Pakistan, *titan* for big or great. Genus *Akimrantitan* pronunciated as Ak-Imran-Titan. Species name *Akimrantitan waqarzaki* honors Waqar Malik the great journalist for his kind and true support to the people of Pakistan and Zaki Ahmad Former Deputy Director General Geological Survey of Pakistan for his significant contribution in mineral resources of Pakistan. Species name *Akimrantitan waqarzaki* pronunciated as Waqar-Zaki .

Diagnosis and Comparison: *Akimrantitan waqarzaki* medium sized sauropod shares with the Titanosauria on the basis of procoelous caudal centra. It shares with Poripuchia because of sharing with Gspsauridae. It shares with Gspsauridae on the basis of transversely expanded distal tibia (**Figure 3**) with medium size and restricted articular condyle of caudals. *Akimrantitan waqarzaki* has following autapomorphies. The holotypic proximal humerus of *Akimrantitan waqarzaki* has relatively strongly more expanded medial process toward medially than all known humeri especially from Indo-Pakistan. The medial process of humerus of *Akimrantitan waqarzaki* has ventrally sub horizontal or almost horizontal profile, while the humeri of *Qaikshaheen masoomniazi*, *Ikqaumishan smqureshi*, *Pakisaurus balochistani, Khanazeem saraikistani, Imrankhanhero zilefatmi, Balochisaurus malkani* and *Nicksaurus razashahi* from Pakistan and *Isisaurus colberti* (Figures 20a, b and 21a, b of [54]) and *Jainosaurus septentrionalis* ([55]; Figure 1 of plate IV and Figure 2 of plate V of [53]) have elongated dorsomedially inclined profile. As humerus is key element considered by [56] for distinction, then this new humerus of *Akimrantitan waqarzaki* is distinct and distinguished from other humeri especially from Indo-Pakistan. Further see below.

Description:

Caudal vertebrae *Akimrantitan waqarzaki* caudal vertebrae GSP/MSM-52-9 and GSP/MSM-526-9 (**Figure 3**) were collected from Grut locality. These caudals are procoelous and somewhat ventrally reduced. A proximal thoracic rib GSP/MSM-321-13 having junction of capitulum and tuberculum (**Figure 3**) was collected. Caudals have restricted articular condyle.

Humerus: *Akimrantitan waqarzaki* holotypic partial left humerus GSP/MSM-237-10 was collected from Rahiwali locality and a proximal humerus with prominent head shown as mosaic of samples GSP/MSM-694-9 and GSP/MSM-759-9 (**Figure 3**) collected from the Grut locality. *Akimrantitan waqarzaki* has distinguished proximal humerus with more expansion of medial process toward the medial side along with sub horizontal ventral profile of medial process, these features are not shown in any titanosaurs especially Indo-Pakistani titanosaurs. Its proximal humerus has medially expanded and prominent medial process (**Figure 3**) and posterior sub plain surface just below the head (**Figure 3**), while *Pakisaurus balochistani* has medially inset, robust and almost straight deltopectoral crest and posterior dorsoventral ridge (with left and right triceps fossa) starting just below the head and runs downward to mid shaft, *Gspsaurus pakistani* has medially inset and almost straight deltopectoral crest with subcircular ridge at base and relatively less medial expansion of proximal humerus, *Qaikshaheen masoomniazi* has almost laterally inset, robust and sinusoidal deltopectoral crest and also relatively less medial expansion of proximal humerus, *Balochisaurus malkani* has smooth posterior plain just below the head and relative more downward migrated head and relatively less expanded medial process, *Imrankhanhero zilefatmi* has medially inset, intermediate (between slender and robust) and sinusoidal deltopectoral crest and relatively less expanded medial process, *Isisaurus colberti* (Figures 20a, b, and 21a, b of [54]) has medially inset and relatively robust deltopectoral crest and relatively less expanded medial process, and *Jainosaurus septentrionalis* ([55];

Figure 1 of plate IV and Figure 2 of plate V of [53]) has also relatively less expanded medial process. *Akimrantitan waqarzaki* holotypic partial left humerus has prominent medial expansion than any other humeri from Indo-Pakistan. The deltopectoral crest of *Akimrantitan waqarzaki* humerus is destroyed and the shaft section (just below the destroyed deltopectoral crest) shows asymmetrical subtriangular shape or asymmetrical D-shaped. Its section has more mediolateral width than anteroposterior depth. The posterior ridge found in mid shaft while subplain surface just below head differentiate it from humeri of *Pakisaurus balochistani* from Pakistan and India [9] [57] and adult and juvenile *Diamantinasaurus matildae* from Australia [58]-[60] and *Rapetosaurus krausei* from Madagascar [61] which have continuous posterior ridge and lack posterior plain area just below head. *Akimrantitan waqarzaki* proximal humerus resembles with partial preserved medial process of left humerus of *Mansourasaurus shahinae* from Egypt (Figure 2n of [62]), while unfortunately the most of the medial process of humerus of *Mansourasaurus* is destroyed. This discovery from Pakistan shows paleobiogeographic link between Indo-Pakistan to Africa (via Madagascar or may be direct) shows migration to South America via Africa. This discovery contradicts the thought of migration from Indo-Pakistan to South America via Antarctica. This discovery also contradicts the thought of isolation of mainland Africa during the post-Cenomanian Cretaceous. Its referred humerus (**Figure 3**) has well developed robust head which is destroyed in holotypic humerus.

Ulna: *Akimrantitan waqarzaki* distal ulna GSP/MSM-252-9 (**Figure 3**) was collected from Grut. Its distal ulna is subtriangular and D-shaped. It has rugosities on ventral view.

Tibia: *Akimrantitan waqarzaki* distal right tibia GSP/MSM-75-9 (**Figure 3**) was collected from Grut locality. A distal left tibia K 27/508 from Pisdura, India [53] was also referred. From Pakistan other distal tibiae include 1 distal tibia of *Nicksaurus razashahi* (Figure 14 of [8]), 2 distal tibiae (and 1 proximal tibia) of *Gspsaurus pakistani* (Figure 14 of [8]), 1 distal tibia (and 1 mid and proximal tibia) of *Khanazeem saraikistani* (Figure 14 of [8]), and 1 distal tibia (and 1 mid and proximal tibia) of *Imrankhanhero zilefatmi* (Figure 14 of [8]). *Akimrantitan waqarzaki* distal tibia is expanded transversely, astragalar fossa is relatively small and located in front of its short process (**Figure 3**) like those of *Gspsaurus* and *Nicksaurus* distal tibiae and differ from those of *Khanazeem* and *Imrankhanhero* distal tibiae from Pakistan which are expanded anteroposteriorly, astragalar fossa is larger and located in the mid/centre between its long and short processes.

Astragalus: *Akimrantitan waqarzaki* astragalus GSP/MSM-752-9 (**Figure 3**) was collected from Grut locality. This specimen is unique in Indo-Pakistan. The general shape of astragalus is transversely long and concave or syncline type with limbs. The medial and lateral parts are truncated. The astragalus fossa at the base of ascending process is present. Astragalous posterior fossa shape is undivided. The lateral surface of the ascending process is straight inclined downward or mildly convexing profile generally inclining downward. This astragalus body is long and concave transversely. It forms the transversely oriented axis syncline with anterior and posterior limbs. These limbs are named as anterior limb and posterior limb due to their occurrences. The anterior limb convex maximum form ridge in the lateral one third distance from lateral corner. From maximum peak or ridge of ascending process, on both sides laterally and also medially the inclination started toward medial and lateral base. Posterior limb behavior is same as anterior limb but difference is that the posterior limb peak is lower than anterior limb. Both limbs trend transversely separated by an elongated depression or groove which is also oriented transversely. Between the anterior and posterior ridges is a deep astragalus fossa. Some description was also found in (page 481 of [9]).

Updated information for some sauropod taxa of Pakistan

According to updated (at late 2025) research on 28 dinosaur taxa (22 bone fossils include 16 sauropods, 5 theropods and 1 ornithischian; and 6 ichnotaxa include 2 sauropods, 2 ornithischian and 2 theropods). 15 titanosaur and 5 theropods taxa from Late Cretaceous (Maastrichtian) Vitakri Formation, 1 ankylosaur ornithischian from Late Jurassic-Early Cretaceous Sembar Formation and 1 diplodocid from possibly middle Jurassic (Bathonian) Shinawari Formation based on bones fossils; and 1 ankylosaur ornithischian from middle Jurassic, 1 hadrosaur ornithischian from Maastrichtian Pab Sandstone, 1 basal sauropod from middle Jurassic Chiltan Limestone, 1 sauropod possibly titanosaur from Maastrichtian Pab Sandstone, 1 large theropod and 1 small theropod from middle Jurassic Samana Suk Limestone based on tracks/trackways. The 6 Pakistani titanosaurs like *Pakisaurus balochistani*, *Imrankhanhero zilefatmi*, *Qaikshaheen masoomniazi*, *Ikqaumishan smqureshi*, *Balochisaurus malkani* and *Akimrantitan waqarzaki* new gnus and new species diagnosed on key humerus (because reference [56] consider humerus as key element). 8 Pakistani titanosaurs like *Pakisaurus balochistani*, *Khanazeem saraikistani*, *Imrankhanhero zilefatmi*, *Nicksaurus razashahi*, *Qaikshaheen masoomniazi*, *Balochisaurus malkani*, *Marisaurus jeffi and Gspsaurus pakistani* on differentiated femora; 8 Pakistani titanosaurs like *Gspsaurus pakistani, Saraikimasoom vitakri, Nicksaurus razashahi, Pakisaurus balochistani, Khanazeem saraikistani* and *Imrankhanshaheen masoombushrai* on distinct crania, all along with other diagnostic features. *Gspsaurus pakistani, Ikqaumishan smqureshi* and *Akimrantitan waqarzaki* of Gspsauridae, *Qaikshaheen masoomniazi* of Balochisauridae, and *Pakisaurus balochistani, Khanazeem saraikistani* and *Imrankhanhero zilefatmi* of Pakisauridae were existed in Pakistan and also India. Checklist of holotypic and referred bones of sauropod taxa (**Table 3**) and Gspsauridae taxa (**Table 4**) are being presented because it is used to know which taxa have more bones and which taxa has relatively less number of bones. Total 354 bones of sauropods include proportion of cranial 51 bones (14.41%), vertebral/axial bones 193 bones (54.52%), 105 appendicular bones (29.66%) and 5 osteoderms 1.41% (**Table 3**). Axial elements are in majority, appendicular are fairly moderate in proportion and cranial elements are considerably less in portion (but hosts significant snouts and distinct crania) and osteoderms are fit in proportions.

Ikqaumishan smqureshi **(holotype and referred fossils)**: It consists of holotypic humerus and paratype vertebrae from south Sangiali. Its referred vertebrae from Top Kinwa and south Kinwa, and armor bone from Dada Pahi locality (**Figure 4**). Dorsoventrally and slightly oblique two long ridges are observed in posterior view of holotypic proximal humerus of *Ikqaumishan smqureshi* (**Figure 4**) which is unique feature among Indo-Pakistani titanosaurs.

Pakisaurus balochistani **Parietal (partial skull roof)**: A parietal GSP/MSM-353-4 (**Figure 5**) was collected with the holotype of *Pakisaurus balochistani* at the same time (pages 494-495 of [9]) and but missed to include in its holotype. So now it may be considered as its paratype. Both holotype and paratypic bones may belong to single individual. Its parietal facet (to connect with fellow parietal) is folded type and uneven interdigitating midline sutures. *Pakisaurus balochistani* parietal facet include coarse interdigitating rounded cones while *Rapetosaurus krausei* [63] have fine interdigitating sharp cones. *Pakisaurus balochistani* parietal facet include 5 interdigitating rounded cones while *Rapetosaurus krausei* [63] have about 10 interdigitating sharp cones. *Pakisaurus balochistani* parietal facet is generally straight while *Rapetosaurus krausei* [63] parietal facet is sligtly concave. *Pakisaurus balochistani* parietal has mild/feeble convexing backward and strong and wide concavity anteriorly on posterior profile observing via dorsal view (**Figure 5**), while *Imrankhanshaheen masoombushrai* [9] parietal has prominant convexity and then prominent concavity. Further most of the medial contact of parietal (with its fellow) of *Imrankhanshaheen masoombushrai* [9] is destroyed and not comparable. *Pakisaurus balochistani* parietal frontal facet (contact face for frontal) is concave and convex folded type (syncline and anticline) like those of *Rapetosaurus krausei* [63] frontal facet. The frontal facet of *Imrankhanshaheen masoombushrai* braincase are not preserved for comparison. *Pakisaurus balochistani* parietal supratemporal fenestra is L-shaped while *Rapetosaurus krausei* [63] supratemporal fenestra is generally rounded shape. The lateroposterior part of *Pakisaurus* parietal is destroyed at the end of long posterior concavity and does not show laterally tapering elongated squamosal process and may resemble with *Quaesitosaurus* [64] in this regard. Posterior view of *Pakisaurus* parietal show a concavity which inclined slightly anteriorly. The dorsoventral depth of concavity decreasing to midline, while this depth is slightly decreased laterally upto preserved portions. This concavity is about 2 cm dorsomedially in the mid. The dorsal margin of concavity of posterior face is slightly rugose. *Pakisaurus* parietal anterior slope of posterior face occur in most titanosaurs (Bara Simla braincase ISI R 162 and Rahioli braincase ISI R 476 [65], Dongergaon braincase ISI R 199 [66], Bara Simla braincase GSI K27/497 [53], *Antarctosaurus wichmannionus* [67], *Nemegtosaurus* [68] [69], *Quaesitosaurus* [64], *Malawisaurus* [70] and *Saltasaurus* [71]. *Pakisaurus* parietal is anteroposteriorly expanded in the mid/centre and reduced significantly laterraly like those of *Rapetosaurus krausei* [63]. Its parietal dorsal surface is rugose (may be showing teeth coating), while *Rapetosaurus krausei* [63] parietal dorsal suface is mostly smooth and medioposaterior portion is rugose. Its elongated rugosities trend from posterolateral to anteromedial direction. *Pakisaurus balochistani* parietal facet is almost straight while Dongargaon sauropod braincae R 199 [66] is not straight but concaving toward left parietal. *Pakisaurus balochistani* parietal frontal facet (contact face for frontal) have coarse rounded folding type interdigitating profile unlike those of Dongargaon sauropod braincae R 199 [66] which have fine sharp interdigitating surfaces. *Pakisaurus balochistani* parietal frontal facet (contact face for frontal) is concave and convex folded type (syncline and anticline) unlike those of Dongargaon sauropod braincae R 199 [66] from India and *Antarctosaurus wichmannianus* [67] braincase MACN 6904 from Argentina which have almost straight profile especially in the medial half portion. *Jainosaurus septentrionalis* braincase GSI K27/497 [53] has incomplete preservation of parietal, so comparison can not be done. *Pakisaurus balochistani* parietal posterior facet is reltaively less concave unlike those of *Nemegtosaurus mongoliansis* [68] [69] from Mongolia.

Pakisaurus balochistani has more deflected/inflected (directed almost upward or dorsally) femoral head relative to shaft (**Figure 5**), while *Khanazeem, Balochisaurus* and *Qaikshaheen* have moderate inflection of femoral head relative to shaft (**Figure 5**), and the referred *Gspsaurus* Kinwa femur has low inflection of femoral head relative to shaft . The more deflected femoral head of *Pakisaurus balochistani* revealed more wide gauge locomotion. *Pakisaurus balochistani* is distinct by its frontal, femur and humerus. *Pakisaurus balochistani* fossils uncovered from Pakistan and India.

Khanazeem saraikistani: *Khanazeem saraikistani* has moderately deflected /inflected femoral head (**Figure 5**), like other titanosaurs from Indo-Pakistan except the *Pakisaurus balochistani* which has more deflected/inflected femoral head (**Figure 5**) and the referred *Gspsaurus* Kinwa femur has low inflection of femoral head relative to shaft. *Khanazeem saraikistani* has concavity on proximolateral profile between greater trochanter and lateral bulge of proximal femur, while *Pakisaurus balochistani* and other titanosaurs especially from Indo-Pakistan lack such concavity. *Khanazeem* femora size is small, while *Pakisaurus* femur is relatively large sized. *Khanazeem saraikistani* fossils uncovered from Pakistan and India.

Nicksaurus razashahi: The updated recognition of holotypic bones includes mid dentary ramus with 6 teeth GSP/MSM-138-4n (**Figure 5**, row 2, p1,2), anterior dentary symphysis with 5 teeth GSP/MSM-315-4n (**Figure 5**, row 2, p3), maxilla/skull element with 1 tooth GSP/MSM-314-4n (**Figure 5**, row 2, p3), cervical vertebrae GSP/MSM-381-4n, GSP/MSM-383-4n and GSP/MSM-212-4n, dorsal vertebra GSP/MSM-382-4n, caudal vertebrae GSP/MSM-347-4n and GSP/MSM-348-4n, caudal chevron GSP/MSM-313-4n, proximal scapula with glenoid GSP/MSM-1096-4n, mid scapula GSP/MSM-380-4n, proximal left humerus (proximal most portion is destroyed) GSP/MSM-377-4n, proximal fibula GSP/MSM-438-4n, proximal radius GSP/MSM-344-4n, left femur GSP/MSM-190-4n, right distal femur GSP/MSM-192-4n, right femur parts GSP/MSM-378-4n and GSP/MSM-270-4n, left and right distal tibiae GSP/MSM-346-4n and GSP/MSM-345-4n, lower tibial shaft cross section GSP/MSM-379-4n. Anterior dentary symphysis GSP/MSM-315-4n (**Figure 5**, row 2, p3) has sub u-shaped curve or sub u-shaped anterior teeth row of lower jaw. In this way upper teeth row may be u-shaped or sub u-shaped. Its anterior dentary GSP/MSM-315-4n has about 5 teeth (**Figure 5**, row 2, p3), mid dentary ramus GSP/MSM-138-4n (**Figure 5**, row 2, p2), has 6 teeth, while distal dentary may have 4 - 6 teeth, in this way dentary teeth expected are 15 - 17, while *Saraikimasoom vitakri* expected dentary teeth (relatively more thick) are 9 - 11. *Nicksaurus razashahi* femur has almost horizontal greater trochanter (**Figure 5**, row 2, p4).

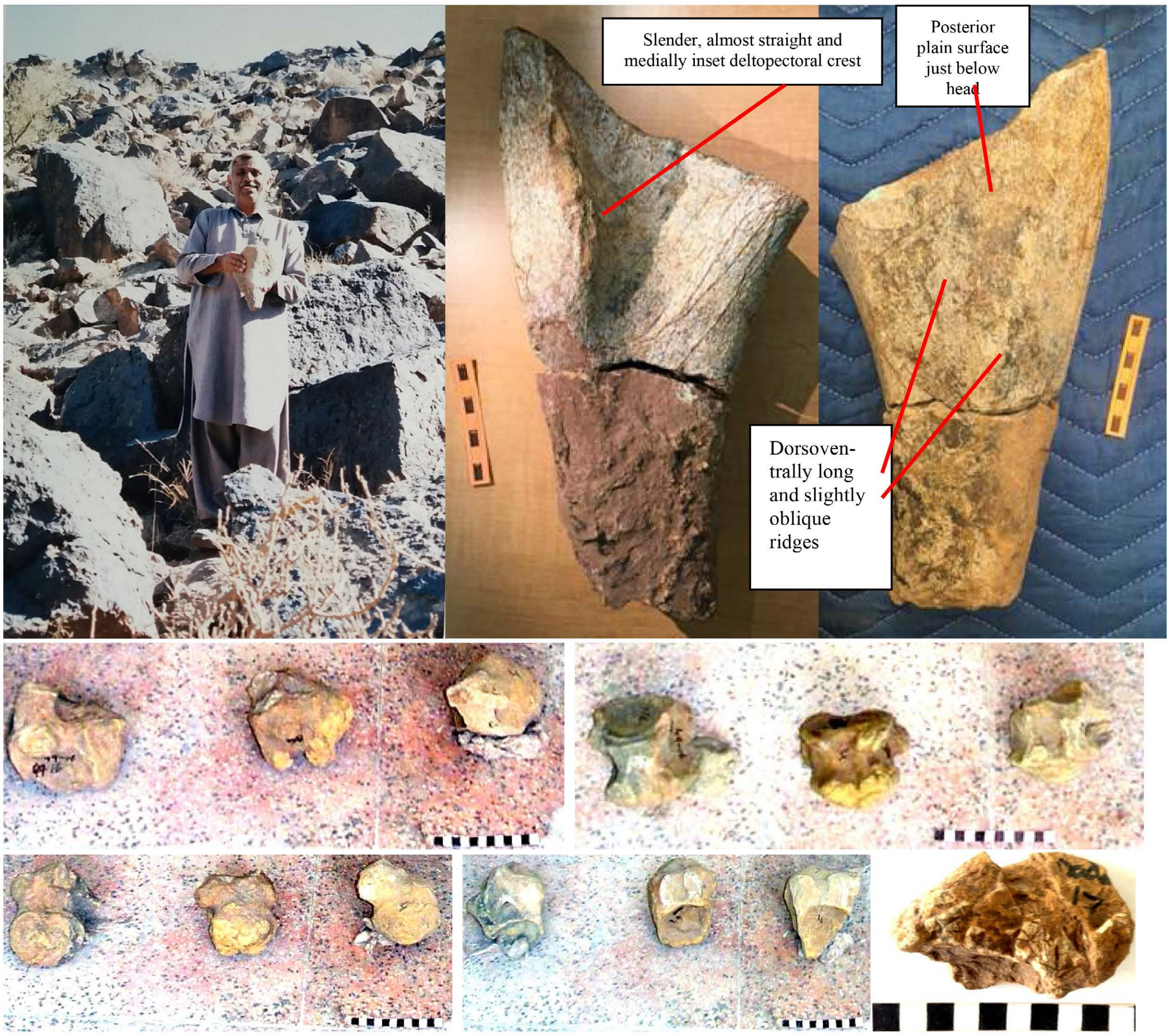

Figure 4. *Ikqaumishan smqureshi* [8] holotype (row 1 except the first photo p1) and referred (Rows 2, 3) bones. **Row 1,** p1**,** M. Sadiq Malkani (of Geological Survey of Pakistan, discoverer of first ever dinosaur bones from Pakistan) standing at the mid Sangiali locality which is the first dinosaur locality in Pakistan. M. Sadiq Malkani presenting in hand a partial humerus (GSP-UM/Sangiali-1124 assigned to *Imrankhanhero zilefatmi*), photographed in 2000; p2, 3, holotypic Humerus (GSP-UM/Sangiali-1125) from south Sangiali in anterior and posterior views. **Rows 2 and 3**, referred anterior caudal vertebrae GSP/MSM-49-16 from Top Kinwa (north western corner of Top Kinwa), GSP/MSM-50-4 and GSP/MSM-51-4 from south Kinwa in lateral (row2, p1) and ventral (row 2, p2), anterior (row 3, p1) and posterior (row 3, p2) views, and armor plate GSP/MSM-1095-17 (row 3, p3) from Dada Pahi locality. Scale, each black or white or yellow digit is 1 cm.

Table 3. Checklist representing holotypic and referred bones of sauropod dinosaurs including 15 titanosaurs and 1 diplodocid from Pakistan. Abbreviations; H for holotype, R for referred fossils.

Region	*Pakisaurus balochistani*		*Khanazeem saraikistani*		*Imrankhanhero zilefatmi*		*Khetranisaurus barkhani*	*Sulaimanisaurus gingerichi*	*Balochisaurus malkani*		*Qaikshaheen masoomniazi*		*Marisaurus jeffi*		*Saraikimasoom vitakri*	*Nicksaurus razashahi*		*Gspsaurus pakistani*		*Maojandino alami*		*Ikqaumishan smqureshi*		*Imrankhanshaheen masoombushrai*	*Akimrantitan waqarzaki*		*Safisaur niazensis*
	H	R	H		H	R	H	H	H	R	H	R	H	R	H	H	R	H	R	H	R	H	R	H	H	P	H
dermal skull	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	1	-	-	-	-	-	-	-	-	-
lower jaw	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-
braincase	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
palate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
teeth	-	-	5	-	-	-	-	-	-	-	-	-	-	-	+23	8	-	+5	-	-	-	-	-	-	-	-	-
cervical vertebrae	9	-	-	-	-	-	-	-	3	-	2	2	-	-	-	4	-	6	-	6	-	-	-	1	-	-	5
dorsal vertebrae	2	-	-	-	-	-	-	-	8	-	4	8	-	1	-	-	1	6	1	6	1	-	-	2	-	-	5
sacral vertebrae	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-
caudal vertebrae	7	4	2	4	1	-	2	7	12	-	3	4	9	6	-	3	9	11	5	11	5	1	3	3	-	2	4
ribs	-	-	-	1	-	-	-	-	5	-	-	2	-	-	-	1	1	-	-	-	-	-	-	2	-	-	1
pectoral girdle	3	1	-	-	-	-	-	-	1	-	2	3	1	1	-	2	-	2	2	2	2	-	-	3	-	-	-
humerus	2	1	2	-	1	-	-	-	1	-	1	2	-	-	-	1	-	-	-	-	-	1	-	-	1	1	-
radius/ulna	3	2	-	1	-	-	-	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-
carpus + manus	3	-	-	-	-	-	-	-	2	-	-	8	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
pelvis	1	1	-	-	-	-	-	-	1	-	1	1	1	-	-	1	-	1	-	1	-	-	-	1	-	-	-
femur	1	-	2	-	1	-	-	-	1	2	1	1	1	-	-	2	-	1	1	1	1	-	-	1	-	-	1
tibia + fibula	2	-	3	-	1	2	-	-	1	-	2	-	-	-	-	3	-	2	1	2	1	-	-	2	-	1	-
tarsus + pes	1	1	-	-	-	1	-	-	-		-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Osteoderm	-	1	-	-	-	-	-	-	-	-		-		-	-	-	-	-	1	-	1	-	1	2	-	-	-
Coprolite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total cranial elements	1	-	6	-	-	-	-	-	-	-	-	-	-	-	+26	9		+8	-	-	-	-	-	1	-	-	-
Total axial elements	20	4	2	5	-	-	2	7	28	-	9	18	9	7	-	8	11	23	6	23	6	1	3	12	-	3	15
Total appendicular elements	16	6	7	1	-	-	-	-	8	-	7	20	3	1	-	9	-	6	4	6	4	1	-	9	1	4	2
Total osteoderm	-	1	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	1	-	1	-	1	2	-	-	-
Total elements	37	11	15	6	4	3	2	7	36	2	16	38	12	8	+26	26	11	+37	11	29	11	2	4	24	1	6	17
Total h + r elements	48		21		7		2	7	38		64		20		+26	37		+48		40		6		24	7		17

Figure 5. Row 1, p1, *Pakisaurus balochistani* paratype (possible holotypic) parietal GSP/MSM-353-4 (possibly a few teeth on its surface) found from South Kinwa; p2, *Pakisaurus balochistani* holotypic femur (including proximal left femur GSP/MSM-595-4 and distal left femur GSP/MSM-200-4) showing dorsally or strong upward directed head; p3, 4, *Khanazeem saraikistani* holotypic femur (proximal left femur GSP/MSM-69-2 and distal condyles GSP/MSM-272-2 and GSP/MSM-265-2) showing moderate inclination of head. **Row 2,** *Nicksaurus razashahi* holotypic crania and femur, p1, 2, mid dentary with articulated 6 teeth GSP/MSM-138-4n (this specimen also host thin and long cranial bone); p3, anterior dentary symphysis (sub u-shaped) with 5 teeth GSP/MSM-315-4n, and maxilla with possible 1 tooth GSP/MSM-314-4n; p4, proximal femur GSP/MSM-190-4n having almost horizontal greater trochanter. Scale, each black or white digit is equal to 1 cm.

Table 4. Checklist and basic information of Gspsauridae Poripuchian titanosaurs found from the Late Cretaceous Vitakri Formation of Pakistan. **Maojandino alami* has same (overlapped) holotypic (except 2 cranial specimens GSP/MSM-79-19 and GSP/MSM-80-19) and referred specimens of *Gspsaurus pakistani*. So it is a junior synonym of *Gspsaurus pakistani*. *Maojandino alami* will stand only when someone considers only 2 cranial specimens GSP/MSM-79-19 and GSP/MSM-80-19 as a whole holotype of *Gspsaurus pakistani*.

Titles	*Gspsaurus pakistani*	*Maojandino alami*	*Ikqaumishan smqureshi*	*Imrankhanshaheen masoombushrai*	*Akimrantitan waqarzaki*
Informal Description	[27]	[28]	-	-	-
Formal Description	[36]	[37]	[8]	[9]	In present research
Holotype	Snout articulated with dentary rami, quadrate, and quadratojugal GSP/MSM-79-19; a partial vomer, palatine, and pterygoid GSP/MSM-80-19; braincase/anterior caudal GSP/MSM-62-19; cervical vertebrae GSP/MSM-107-19, GSP/MSM-108-19, GSP/MSM-109-19, GSP/MSM-437-19, GSP/MSM-220-19, GSP/MSM-502-19; dorsal vertebrae GSP/MSM-110-19, GSP/MSM-111-19, GSP/MSM-112-19, GSP/MSM-617-19; anterior caudal vertebrae GSP/MSM-218-19, GSP/MSM-219-19; caudal vertebrae GSP/MSM-113-19,	*Same as *Gspsaurus pakistani* except the cranial specimen (GSP/MSM-79-19 and GSP/MSM-80-19). (Figure 10 & Figure 11).	Proximal and mid humerus GSP-UM/Sangiali-1125. (Figure 13 of [8]). (**Figure 4**).	Braincase (GSP/MSM-2-16 and GSP-UM 7000); cervical vertebra GSP/MSM-131-16; dorsal vertebra GSP/MSM-132-16; anterior dorsal vertebra GSP/MSM-256-16; dorsal vertebrae with ventral ridge GSP/MSM-774-16 and GSP/MSM-511-16; two coossified sacral vertebrae GSP/MSM-137-16; two coossified sacral vertebrae GSP/MSM-776-16; anterior caudal vertebra GSP/MSM-34-16; mid-caudal vertebra GSP/MSM-35-16; distal caudal vertebra GSP/MSM-153-16; left and right proximal scapulae GSP/MSM-250-16 and GSP/MSM-176-16; mid humerus GSP/MSM-468-16; left and right proximal ulna GSP/MSM-175-16 and GSP/MSM-240-16; distal ulna	Partial humerus including proximal and mid portion GSP/MSM-237-10 (**Figure 3**).

	GSP/MSM-114-19, GSP/MSM-115-19, GSP/MSM-116-19, GSP/MSM-117-19, GSP/MSM-221-19, GSP/MSM-696-19, GSP/MSM-777-19; neural arch GSP/MSM-146-19; left and right partial proximal scapula GSP/MSM-1100-19, GSP/MSM-217-19; proximal radius GSP/MSM-215-19; partial ilium GSP/MSM-216-19; proximal left femur GSP/MSM-213-19; distal left femur GSP/MSM-118-19; proximal left tibia GSP/MSM-119-19; distal left tibia GSP/MSM-569-19; distal right tibia GSP/MSM-710-19. (Figures 8, 9 & 10 of [9]).			GSP/MSM-74-16; distal radius GSP/MSM-160-16; metacarpal GSP/MSM-1036-16; acetabulum in 2 pieces GSP/MSM-147-16 and GSP/MSM-148-16; proximal right tibia biconvex lense shaped GSP/MSM-73-16; left and right proximal fibulae GSP/MSM-76-16 and GSP/MSM-77-16; convex part of sternal GSP/MSM-1014-16; sternal part GSP/MSM-604-16; part of ilium GSP/MSM-557-16; part of neural spine or armor spine with wound mark GSP/MSM-150-16; vertebral process/neural spine GSP/MSM-391-16; cervical ribs GSP/MSM-328-16, GSP/MSM-329-16; neural spine GSP/MSM-767-16; mosaic type osteoderms GSP/MSM-83-16, GSP/MSM-1035-16. (Figures 6 & 7 of [9]).	
Holotypic elements	33	31*	1	33	1
Type locality	Alam (central Alam) (latitude 29˚41'0.7"N; longitude 69˚23'58"E; Figure 4 of [36]).	*central Alam	Upper Sangiali or South Sangiali (Figure 4 of [36]) latitude 29.69809N and longitude 69.39882E.	Top Kinwa (Figure 4 of [36]), at latitude 29.68809 N and longitude 69.4002 E (N 29˚41'17.60"; E 69˚24'0.72") of Pakistan.	Rahiwali (Rahi Wali) locality (Figure 1 of [37]); 29˚42'19"; E 69˚29'08" of Pakistan.
Referred specimens	Postzygapophyses GSP/MSM-638-19c from Alam type locality; Neural arch of anterior-mid dorsal vertebra GSP/MSM-82-4; anterior caudal vertebra GSP/MSM-36-4; mid caudal vertebrae GSP/MSM-37-4, GSP/MSM-38-4, GSP/MSM-39-4, and GSP/MSM-39(a)-4; mid scapular blade with ridge GSP/MSM-838-4; right mid and proximal scapula GSP/MSM-198-4; proximal and mid femur GSP/MSM-208-4; and osteoderm ellipsoidal plate GSP/MSM-85-4 from south Kinwa. Proximal tibia GSP/MSM-181-2 and proximal tibial shaft GSP/MSM-850-2 from east Bor, Pakistan (Figure 11 of [9]). Distal right slender femur GSP/MSM-71-15 (Figure 17 of [9]) from southern Mari Bohri, referred on the basis of slenderness and size (Pakistan). A caudal vertebra K20/317 and a humerus from Bara Simla India [53] and right and left humeri, right radius, left femur, left tibia and left fibula of Chhota Simla limb skeleton [56] [72] from India were referred [32] [36].	*Same as *Gspsaurus pakistani*	Simple armor plate or osteoderm estimated about 5cm in diameter and 1 cm in depth GSP/MSM-8-1 (GSP-BC-001/01) from western bank of Sangiali locality just opposite of mid Sangiali which was received in 2001 by Dr David Krause of Boston College (then), USA for preparation; Anterior caudal vertebra GSP/MSM-49-16 from Top Kinwa (north western corner of Top Kinwa); anterior caudal vertebrae GSP/MSM-50-4 and GSP/MSM-51-4 from south Kinwa; and sub oval armour bone (GSP/MSM-1095-17) from Dada Pahi 17 locality, Pakistan. (Figure 12 of [9]) (**Figure 4**). Some vertebrae and limb bones from upper Sangiali locality of Pakistan observed in the field and not collected from Pakistan. Referred right and left humeri (78 cm length) GSI type no 20010 (Figures 1a, b, of Plate 1 of [57]) and GSI 20011 [57] reported from Rahioli locality, Gujarat state, India were referred [8].	-	Caudal vertebrae GSP/MSM-52-9, GSP/MSM-526-9, proximal humerus with prominent head GSP/MSM-694-9 and GSP/MSM-759-9, distal ulna GSP/MSM-252-9, transversely broad distal tibia GSP/MSM-75-9 and right astragalus GSP/MSM-752-9 (**Figure 3**) from Grut locality (Figure 1 of [37]); Further distal humerus GSP/MSM-236-11, proximal part of ulna GSP/MSM-919-11 and a few section/part of bones GSP/MSM-561-11, GSP/MSM-562-11, GSP/MSM-563-11, GSP/MSM-758-11 and GSP/MSM-920-11 from northeast Dolwahi (Dolwahi) locality PDL 11, a few bones from east-northeast Dolwahi locality 12, and proximal thoracic rib GSP/MSM-321-13 (**Figure 3**) from east Dolwahi locality 13 (Figure 1 of [37]), Pakistan. From India a robust transversely expanded distal tibia K27/508, left metatarsal K27/509 and left ischium K27/510 from Pisdura, west of Dongargaon (Figures 1, 2, 3 of Plate VII of [53]) is being referred to *Akimrantitan waqarzaki* based on overlapping of robust tibia with small astragalous fossa situated in

					front of short process. Further caudal vertebra K 27/501 from Pisdura India (Figure 1 of Plate VIII of [53]) is also being referred due to moderately reduced ventral view than dorsal view.
Referred Elements	13 elements from Pakistan; 8 elements from India. 13 + 8 = 21	*Same as *Gspsaurus*	5 + 2 = 7	-	6
Referred localities	East Bor 2 and South Kinwa 4 (Figure 4 of [36]) from Pakistan. Chhota Simla [56] [72] and Bara Simla [53] localities of Jabalpur, central India and Rahioli [57] locality of Gujarat state of western India.	*Same as *Gspsaurus*	Dada Pahi 17, east Alam 18, top Kinwa 16 and south Kinwa 4 (Figure 4 of [37]), Pakistan. Rahioli [57], Gujarat, western India.	-	Grut 9 and east Dolwahi localities (Figure 1 of [37]) of Dhaola Range, Pakistan. Pisdura (west of Dongargaon) from central India [53].
Total holotypic and referral elements	33 + 21 = 54	*31 + 21 = 52	1 + 7 = 8	33	1 + 6 = 7
Total Individuals	5	*5	6	1	2
Horizon/ Formation	Vitakri Formation; Lameta Formation	Vitakri & Lameta	Vitakri Formation. Lameta Formation	Vitakri Formation	Vitakri Formation
Age	Late Cretaceous (Latest Maastrichtian)	Latest Maastrichtian	Latest Maastrichtian	Latest Maastrichtian	Late Cretaceous (Latest Maastrichtian)
Distribution Territory; (Basin) wise	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin), Pakistan. Chhota Simla and Bara Simla localities of Jabalpur, central India and Rahioli locality of Gujarat state of western India.	Barkhan Distt, Balochistan, Sulaiman Basin, Pakistan. Chhota Simla, Bara Simla and Rahioli (India)	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin) (Pakistan). Rahioli, Gujarat (western India)	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin) (Pakistan).	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin) Pakistan.

Qaikshaheen masoomniazi: 10 - 20 m away toward northeast from type locality of *Khetranisaurus barkhani*, a few caudal vertebrae and a slender femur was observed in the field (not collected). These caudals vertebrae resemble closely on ventral reduction and size and proportions, and also a slender femur resemble closely with holotypic and referred femora of *Qaikshaheen masoomniazi* on size and slenderness. I suggest these are referable to *Qaikshaheen masoomniazi*.

3.4. First Diplodocid Dinosaur from Indo-Pakistan Subcontinent and Asian Continent Found from Kohat Area of Khyber Pakhtrunkhwa, Pakistan

The Jurassic era in Kirthar Range (*Brohisaurus* [13]) and Kohat Range (*Safisaur niazensis* new genus and new species, presented here) of Pakistan yielded poorly preserved and poorly recognized bones so far. The fossils (with larger pictures) of first diplodocid from Pakistan and also from Indo-Pakistan were reported by [43] [44] [45]. The first diplodocid (*Safisaur niazensis* new genus and species) were informally reported in September 2025 by [45] and here being formally reported.

Systematic paleontology

Dinosauria; Saurischia; Sauropoda; Neosauropoda; Diplodocoidea; Flagellicaudata; Diplodocidae; *Safisaur niazensis*, new genus and new species (**Figure 6**).

Holotype: KUST-DM-NM-1/2025, represents axial elements (include partial cervical, dorsal and caudal vertebrae, neural arches, distal thoracic rib and chevron) and limb elements (include proximal femur and a metatarsal 1) (**Figure 6**) found from Kohat Development Authority (KDA) locality. The holotype was collected (from the dump of stones, soil, and other sedimentary materials, which were dug, and the area was made plain for the construction of houses in the KDA) and hosted by Prof. Dr. Niaz Muhammad, Department of Microbiology, Kohat University of Science and Technology, Kohat District, Khyber Pakhtunkhwa, Pakistan. The recognition of some bones are poor and based on shape, size and features as described below. These materials were collected during last week of August and first week of September 2025. All holotypic materials belong to a single individual because found on one locality and one site, size agreements and no duplication.

Type locality, horizon, and age: Holotype was found in the KDA Locality with grid reference N 33.602729; E 71.468012, or latitude 33˚36' North, and longitude 71˚28' East, Kohat District, Khyber Pakhtunkhwa Province, Pakistan (**Figure 6**, row 1, p1). Kohat area belongs to lateral extension of Samana Range which hosts the exposed Jurassic (oldest) and Cretaceous rocks in the core. The Early Jurassic Datta Formation (terrestrial sandstone) is thin in the Kohat area and surroundings, Early to Middle Jurassic Shinawari Formation (shale, limestone, marl and sandstone) which hosts Bathonian aged upper part as red/maroon rocks (expected fossils host rocks as shown in (**Figure 1**), which were dug shown in (**Figure 6**, row 1, p2), Middle Jurassic (Late Bathonian to Callovian) Samana Suk Limestone and possible disconformity at Jurassic-Cretaceous boundary, the Early Cretaceous Chichali Formation (marine shale) (Lumshiwal sandstone may be missing here), Late Cretaceous Kawagarh Formation (marine limestone and minor marl and shale) and latest Cretaceous Indus Formation (lateritic and bauxitic beds) [1] [3] [4]. The typical robust and shallow bifid neural spines show affinity with diplodocid range from middle or Late Jurassic to Early Cretaceous. This age range is consistent and close with the red upper part of Middle Jurassic Shinawari Formation and middle Jurassic diplodocoid from India [73].

Etymology: *Safisaur*, in honor of Professor Dr. Amtyaz Safi, Department of Zoology, Diwan Diyaram Jethmal (D.J.) Sindh Government Science College, Karachi involved in this discovery, and *saur* for lizard. Genus name *Safisaur* is pronounced as Safi-saur. Species name *Safisaur niazensis*, in honor of Professor Dr. Niaz Muhammad, Department of Microbiology, Kohat University of Science and Technology for this discovery. Species name *Safisaur niazensis* is pronounced as Niaz-ensis.

Diagnosis and Comparison: *Safisaur niazensis* small to medium sized sauropod shares with Diplodocidae on the basis of distinctive shallow bifurcation of neural arch, more extensive pneumaticity and complex pneumatic structures particularly in neural arches and lateral expansion of each limb of bifid neural spine of posterior dorsal vertebrae. *Safisaur niazensis* has the unique combination of following features. *Safisaur niazensis* has slightly broad and ventrally reduced caudal centrum like those of caudal centrum of *Pilmatueia faundezi* from Early Cretaceous of Argentina [74] and *Brachytrachelopan mesai* [75] from Late Jurassic of

Argentina, while *Tharosaurus* [73] from India has tall centrum. *Safisaur* has expanded distal limb of bifurcated neural spine of anterior cervicals like those of MOR 592 Diplodocidae species and ANS 21122 *Suuwassea* diplodocid (Figure 3 of [76]) [77]. But *Safisaur* has subcircular terminal limb expansion (**Figure 6**, row 3, p1) of bifurcated neural spine of anterior cervical vertebrae, while MOR 592 Diplodocidae species and ANS 201122 *Suuwassea* [76] diplodocid have subtriangular shaped expansion (Figure 3 of [78]) of terminal limb of bifid spine. *Safisaur* has sub v-shaped or sub u-shaped medial cavity at the base with tight/close/narrowly oriented limbs (narrowly bifurcated two branches of spine) of posterior cervical/anterior dorsal vertebra like those of *Suuwassea emilieae* ANS 201122 diplodocid from Montana, USA [76] and MOR 592 Diplodocidae species (Figure 4 of [78]), while *Tharosaurus indicus* from India may has no clear medial cavity or may have broad internal cavity at tip (Figure 2j, 2k of [73]), *Diplodocus carnegii* CM 84 [79] has u-shaped internal cavity, *Pilmatueia faundezi* has sub v-shaped medial cavity but it is open and more diverged two (bifurcated) spines (not tight) [74], and Rebbachisaurid UNPSJB-PV 1005 from Argentina [80] have u-shaped medial cavity found more dorsally at the upper part of spine where bifurcation started. *Safisaur* has shallow (dorsally migrated) bifid neural spine bifurcated in to two limbs which are located closely with each other and its medial cavity is more reduced than *Amargasaurus* from Argentina [81], while *Dicraeosaurus* from Tanzania Africa [82] and *Pilmatueia* [74] have v-shaped broad two limbs of spines and have also broad v-shaped medial cavity. *Safisaur niazensis* have relatively more broad medial cavity between two limbs of bifid neural spine, while *Suuwassea emilieae* [76] diplodocid from Jurassic of Montana, USA, has more closed or tight medial concavity. The two limbs of bifid neural spine of *Safisaur niazensis* are tightly close and directed dorsally with each other like those of *Suuwassea emilieae* ANS 201122 diplodocid from Montana, USA [76] and MOR 592 Diplodocidae species (Figure 4 of [78]), while in *Apatosaurus* and *Diplodocus* this limbs are more away/spaced and directed dorsolaterally [77]. The limbs of bifid neural spine are tight/narrow in *Safisaur niazensis*, *Suuwassea emilieae* and MOR 592 Diplodocidae species, while broad and relatively short in *Diplodocus* and more broad transversely in *Apatosaurus* [77]. In *Safisaur* the bifurcation of neural spine (is shallow) started just above the dorsal margin of diapophyses of posterior cervical/anterior dorsal vertebra like those of *Diplodocus*, *Apatosaurus* and *Suuwassea*, while contrary in *Dicraeosaurus* the bifurcation of neural spine (is deep) started below the dorsal margin of diapophyses of anterior dorsal vertebra (Figure 17 of [77]). The cross section of each limb of bifid neural spine of posterior cervical/anterior dorsal vertebra of *Safisaur* is triangular, while it is elliptical in dicraeosaurid. *Safisaur* has more extensive internal pneumaticity like those of diplodocid and unlike those of dicraeosaurid which have reduced pneumaticity. The limbs are tight in *Safisaur niazensis*, while more tightly in CM 555 *Apatosaurus excelsus* (Figure 3 e of [78]) and more wide in CM 84 (Figure 3 e of [78]). *Safisaur* has robust and sub triangle shaped at the base (with more medial portion thick) of each limb of bifid spines. *Safisaur* distal end of each limb of bifid spine of posterior cervical/anterior dorsal vertebra is not expanded (**Figure 6**, row 3, p2, 3) like those of diplodocid MOR 592 (Figures 4, 5 of [78]). *Safisaur* distal end of each limb of bifid neural spine of posterior dorsal vertebrae is typically strongly laterally expanded (**Figure 6**, row 3, p4, 5) like those of diplodocid MOR 592 (Figure 6 of [78]). *Safisaur* has possible thoracic distal rib with rounded end. This rib has dorsoventral convexity on laterodorsal side. *Safisaur* chevron is transversely compressed. Chevron has tightly oriented two processes which are also transversely compressed. Its each process is robust. The robust Metatarsal I with trapezoid shape (**Figure 6**) of *Safisaur* resemble with *Suuwassea emilieae* but *Safisaur* metatarsal I is more pneumatic.

Description

Axial elements: Axial elements collected are partial cervical, dorsal and caudal vertebrae, neural arches, distal thoracic rib and chevron (**Figure 6**). A few vertebrae including centra with transverse processes were recognized (**Figure 6**, row 1, p3-5). Centra are broad and have transverse process. One anterior caudal cenrum (**Figure 6**, row 1, p3) is broad, pneumatic, ventrally reduced and has transverse process laterally and chevron facets ventrally. The other centra (**Figure 6**, row 1, p4, 5) are also broad, pneumatic and have transverse processes. Their parapophyses are not clear due to damage. The transverse processes found are almost horizontally straight and blunted (**Figure 6**, row 1, p3, 4). The centra are ventrally concave or arced (**Figure 6**, row 1, p5). One centrum of *Safisaur niazensis* is slightly broad and some what ventrally reduced (**Figure 6**, row 1, p3), like those of *Pilmatueia faundezi* from Argentina [74], while *Tharosaurus* from India has more broad (but lack ventral reduction) centrum [73]. The transverse processes found are almost horizontally straight in *Safisaur niazensis*, while in *Tharosaurus indicus* from India [73] they are recurved downward. The neural canal of *Safisaur niazensis* seems to be more broad than *Tharosaurus indicus* [74]. The most complete neural arch (**Figure 6**, row 2, p1-3) of posterior cervical or anterior dorsal vertebra includes the articulated partial bifid neural spine (two limbs/parts of neural spine are separated by a cavity), postzygapophyses, prezygapophyses and diapophysis. Bifurcated neural spines character is phylogenitically important in Diplodocoidea due to widespread occurrences [78]. Bifurcation of neural spines absent or preliminary in juvenile, while bifurcation is well developed in adults [78]. In *Safisaur niazensis* the bifurcation is well developed, so it belongs to adult animal. Further pneumaticity in *Safisaur niazensis* shows its adultness. *Safisaur niazensis* two limbs of bifid neural spine are thick medially, while in *Tharosaurus indicus* from India [73] are thick laterally. *Safisaur niazensis* has robust and sub triangle shaped at the base with more medial portion thick of each limb of bifid spines. *Safisaur* two brances of neural spine is narrowly bifurcated. *Safisaur niazensis* two limbs of bifid neural spine are separated by medial cavity, while in *Tharosaurus indicus* from India [73] two parts of neural spine (Figure 4, g, h, I, j, k, l of [73]) are not separated by medial cavity. Diapophyses are also found laterally in this neural arch. Prezygapophysis and postzygapophysis are subcircular. (**Figure 6**, row 2, p1-3). A distal part of a limb of bifid neural spine of anterior cervical vertebra (**Figure 6**, row 3, p1) is subcircular and more expanded. Distal parts of limbs of bifid neural spine of posterior cervical and anterior dorsal vertebrae (**Figure 6**, row 3, p2,3) are straight and less expanded or not expanded. Distal parts of limbs of bifid neural spine of posterior dorsal vertebrae (**Figure 6**, row 3, p4, 5) are typically expanded laterally. A distal rib (**Figure 6**, row 3, p6) is rounded and host dorsoventrally convexity on one side. Left and right postzygapophysis (**Figure 6**, row 4, p1) of cervical vertebrae (because away from midline) are subcircular. A robust diapophysis (**Figure 6**, row 4, p2) of cervical vertebra is robust. A transversely compressed chevron has two transversely compressed processes (**Figure 6**, row 4, p3). The comparisons of many features are also shown above.

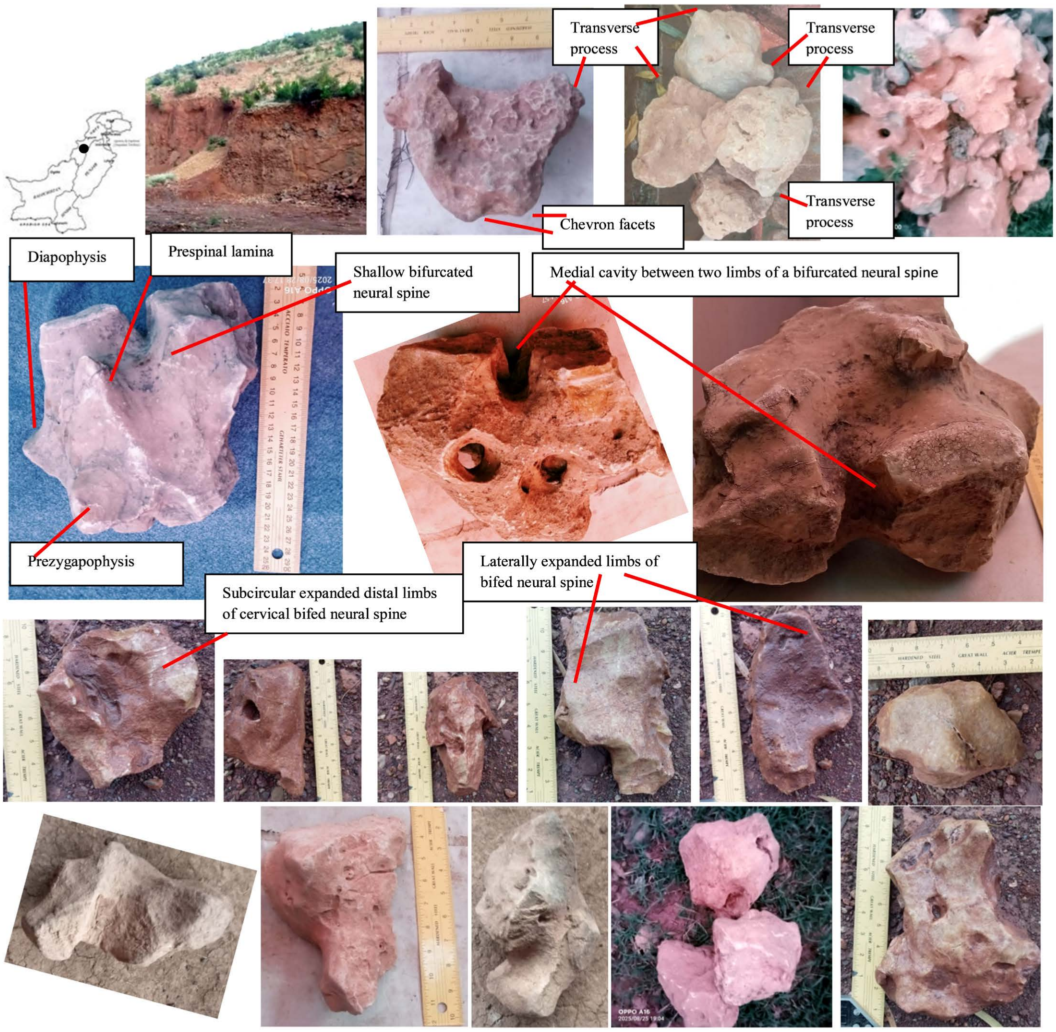

Figure 6. *Safisaur niazensis* new genus and new species holotypic materials (KUST-DM-NM-1/2025 represented in rows 1 to 4, except first two photos p1, 2 of row 1). **Row 1**, p1, black circle in map of Pakistan showing KDA type locality; p2, digged host rocks of holotypic materials; p3, caudal centrum with transverse processes; p4, 5, vertebrae with transverse processes. **Row 2**, p1, 2, 3, neural arch of posterior cervical vertebra (in anterior, posterior and dorsal views) including partial postzygapophyses, prezygapophyses, diapophyses and shallow bifid neural spine. **Row 3,** p1, subcircular distal neural spine limb of anterior cervical vertebra; p2, 3, distal neural spine limb (not expanded) of bifid spines of posterior cervical and or anterior dorsal vertebrae; p4, 5, laterally expanded distal limbs of bifid neural spines of posterior dorsal vertebrae; p6, distal thoracic rib. **Row 4**, p1, postzygapophyses of cervical vertebra; p2, diapophysis of possible posterior cervical/anterior dorsal; p3, chevron; p4, proximal femur? (upper); p5, Metatarsal I. Scale is in cm. NM abbreviated fossil collector name Niaz Muhammad.

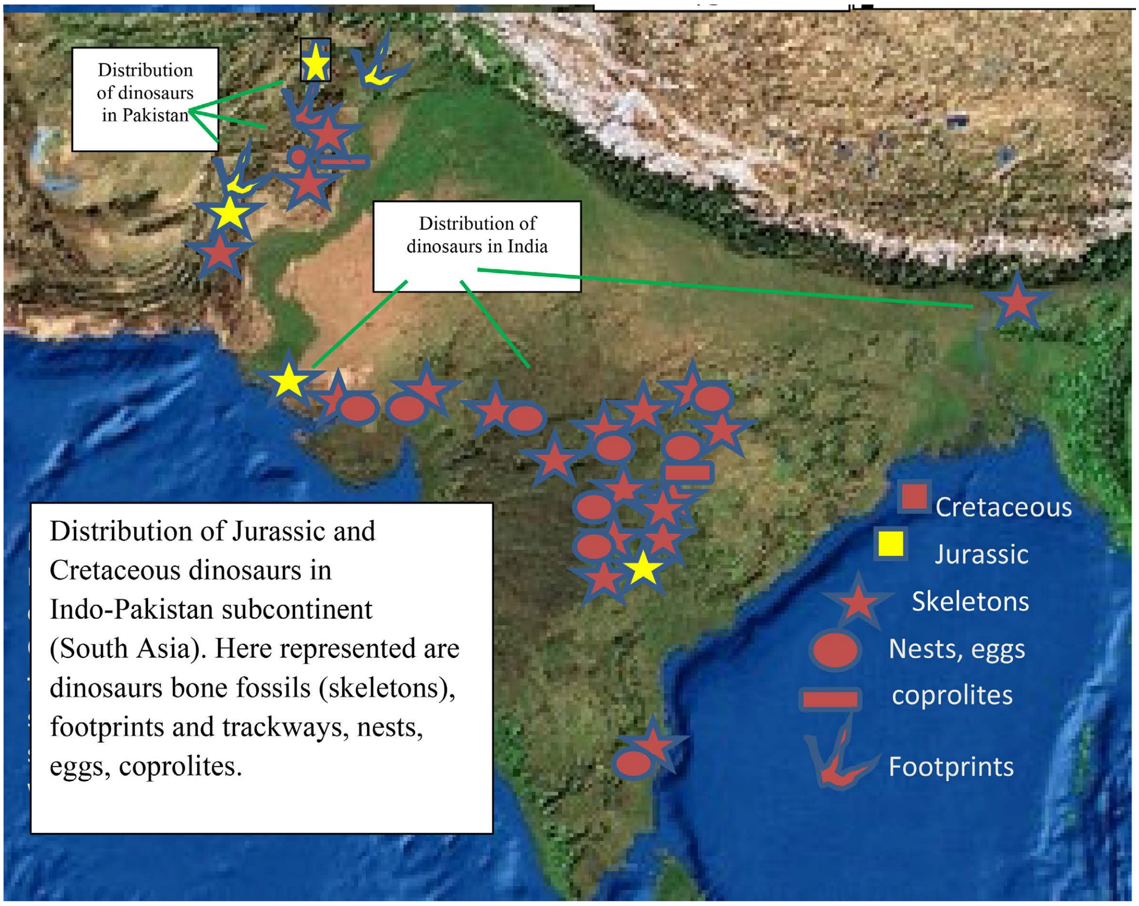

Figure 7. Distribution of Jurassic and Cretaceous dinosaurs in Indo-Pakistan subcontinent (Figure updated after [29] [83]).

Limb elements: Limb elements collected are a proximal femur and a metatarsal I. A proximal femur (**Figure 6**, row 4, p4) was poorly recognized only on the basis of greater trochanter like inclination and medial curvature like profile. A Metatarsal I (**Figure 6**, row 4, p5) is spongy and robust. The robust Metatarsal I with trapezoid shape resemble with *Suuwassea emilieae* (Figure 3g of [76]) diplodocid but *Safisaur* metatarsal I is more pneumatic. Its lateral side is more anteroposteriorly than medial side. It's proximal articular surface inclined mediodorsally and its posterior surface inclined medio anteriorly, in this way medial anterioroposterior length is less than lateral anteroposterior length and resuslatnly trapezoid shape appear.

Discussion and phylogenetic link with Diplodocidae: Neural spine bifurcation is unusual character present in cervical and dorsal vertebrae of some neosauropods [79]. Bifurcated neural spines are phylogenetically important features especially within Diplodocoidea [78]. The shallow bifurcation of neural arch of *Safisaur* also helps to assign with in Diplodocidae, because deep bifurcation of neural arch is found in Dicraeosauridae. *Safisaur niazensis* bifurcated neural spines is shallow like those of diplodocid. *Safisaur niazensis* (**Figure 6**) closely resemble with MOR 592 diplodocid on the basis of subcircular and expanded distal ends of each limb of bifid neural spine of anterior cervical (Figure 3 of [78]), tight or close occurrences of two elongated limb with short and thin medial cavity of a bifid neural spine in posterior cervical vertebrae (Figure 4 of [78]), two elongated and not expanded distal parts of each limbs of bifid neural spine in anterior dorsal (Figure 5 of [78]), shape of diapophysis process of cervical vertebra (Figure 4 of [78]), and especially typically laterally expanded (started just after the bifurcation) two elongated limbs of bifid neural spine of posterior dorsal vertebrae (Figure 6 of [78]). *Safisaur* has broad centra (**Figure 6**, row 1, p4, 5), while MOR 592 diplodocid has slightly tall centra (Figure 3, 4, 5, 6 of [78]). Most of the cervical and dorsal features of *Safisaur niazensis* resemble closely to MOR 592 (specie*s of Diplodocus*, diplodocid (Figure 3, 4, 5, 6 of [78]) from Late Jurassic Morrison Formation of North America and differ mostly from *Amargasaurus* and *Dicraeosaurus*. The robust metatarsal I of *Safisaur niazensis* (row 4, p5 of **Figure 6**) closely resembles to metatarsal I of *Suuwassea emilieae* (Figure 3 of [76]). The *Suuwassea emilieae* was considered a diplodocid [77], again the *Safisaur* link is going toward diplodocid. *Safisaur* has more extensive internal pneumaticity and more extensive pneumaticity and complex pneumatic structures (in mature individuals) particularly in neural arches like those of diplodocid, while dicraeosaurid generally lack pneumatization in dorsal and caudal vertebrae, although some internal chambers are present (reduced pneumaticity) in base of neural spine or in certain cervical vertebrae. So *Safisaur* is being considered a diplodocid. Diplodocid is not known from India [83]. Previously a claim of first diplodocid from Asia was interpreted on caudal vertebra [84] which was later interpreted as titanosauriform [85]. If the present interpretation is true, then *Safisaur* increases the distribution (**Figure 7**) and also increases middle Jurassic temporal range of Diplodocid which helps for its radiation and dispersal. The *Safisaur* is first diplodocid dinosaur from Pakistan and also first diplodocid from Indo-Pakistan subcontinent and Asia. *Safisaur* is oldest diplodocid discovered from Pakistan which helps for the study of its radiation and dispersal in the globe.

4. Conclusion

This report provides geology and mineral resources of some districts of different provinces of Pakistan, recently discovered paleontological sites and a new titanosaur with some updates and first dinosaur from Khyber Pakhtunkhwa Province of Pakistan, and first diplodocid dinosaur from Indo-Pakistan and Asia. More geological and paleontological exploration is needed to collect more bones inside the dumped materials and host bed rocks and also solve the problem of stratigraphic position and age of *Safisaur niazensis*.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Fatmi, A.N. (1977) Mesozoic. In: Shah, S.M.I., Ed., *Stratigraphy of Pakistan*, Geolog-

ical Survey of Pakistan, 29-56.

[2] Ahmad, Z. (1969) Directory of Mineral deposits of Pakistan. Geological Survey of Pakistan, 1-200.

[3] Malkani, M.S. and Mahmood, Z. (2016) Revised Stratigraphy of Pakistan. Geological Survey of Pakistan, 1-87.

[4] Malkani, M.S. and Mahmood Z. (2017) Stratigraphy of Pakistan. Geological Survey of Pakistan, 1-134.

[5] Malkani, M.S. and Mahmood, Z. (2016) Mineral Resources of Pakistan: A Review. Geological Survey of Pakistan, 1-90.

[6] Malkani, M.S. and Mahmood, Z. (2017) Mineral Resources of Pakistan: Provinces and Basins Wise. Geological Survey of Pakistan, 1-179.

[7] Malkani, M.S. (2011) Stratigraphy, Mineral Potential, Geological History and Paleo-Biogeography of Balochistan Province, Pakistan. *Sindh University Research Journal* (*Science Series*), **43**, 269-290.

[8] Malkani, M.S. (2023) A Glance on the Mineral Deposits and Stratigraphic Sequential Variations and Structures in Different Sections of Indus Basin (Pakistan): New Titanosaurian Sauropod Dinosaurs from the Latest Maastrichtian Vitakri Formation of Pakistan. *Open Journal of Geology*, **13**, 1069-1138. https://doi.org/10.4236/ojg.2023.1310046

[9] Malkani, M.S. (2024) New Data on Coal, Gypsum, Iron and Silica Sand Deposits and Geochemical Exploration (Pakistan): Revision of 25 Years History of Dinosaur Discoveries from Pakistan. *Open Journal of Geology*, **14**, 431-511. https://doi.org/10.4236/ojg.2024.143020

[10] Malkani, M.S. (2025) Theropods, Ornithischians and Pterosaurs from South Asia-Review with New Taxa: A Look at Paleontology, Stratigraphy and Mineral Potential of Pakistan. *Open Journal of Geology*, **15**, 22-68. https://doi.org/10.4236/ojg.2025.151002

[11] Malkani, M.S. and Anwar, C.M. (2000) Discovery of First Dinosaur Fossil in Pakistan, Barkhan District, Balochistan. *Geological Survey of Pakistan*, *Quetta*, *Information Release*, **732**, 1-16.

[12] Malkani, M.S. (2003) Discovery of Partial Skull and Dentary of Titanosauria (Sauropod Dinosaur) from the Late Cretaceous Pab Formation of Vitakri Area, Barkhan District, Balochistan, Pakistan. *Geological Bulletin*, *University of Peshawar*, **36**, 65-71.

[13] Malkani, M.S. (2003) First Jurassic Dinosaur Fossils Found from Kirthar Range, Khuzdar District, Balochistan, Pakistan. *Geological Bulletin*, *University of Peshawar*, **36**, 73-83.

[14] Malkani, M.S. (2003) Pakistani Titanosauria; Are Armoured Dinosaurs? *Geological Bulletin University of Peshawar*, **36**, 85-91.

[15] Malkani, M.S. (2004) Saurischian Dinosaurs from Late Cretaceous of Pakistan. *Fifth Pakistan Geological Congress*, Islamabad, 14-15 April 2004, 71-73.

[16] Malkani, M.S. (2006) Biodiversity of Saurischian Dinosaurs from the Latest Cretaceous Park of Pakistan. *Journal of Applied and Emerging Sciences*, **1**, 108-140.

[17] Malkani, M.S. (2006) Cervicodorsal, Dorsal and Sacral Vertebrae of Titanosauria (Sauropod Dinosaurs) Discovered from Latest Cretaceous Dinosaur Beds/Vitakri Member of Pab Formation, Sulaiman Foldbelt, Pakistan. *Journal of Applied and Emerging Sciences*, **1**, 188-196.

[18] Malkani, M.S. (2006) First Rostrum of Carnivorous Vitakridrinda (Abelisaurids The-

ropod Dinosaur) Found from the Latest Cretaceous Dinosaur Beds (Vitakri) Member of Pab Formation, Alam Kali Kakor of Vitakri Area, Barkhan District, Balochistan, Pakistan. *Sindh University Research Journal* (*Science Series*), **38**, 5-24.

[19] Malkani, M.S. (2006) Lithofacies and Lateral Extension of Latest Cretaceous Dinosaur Beds from Sulaiman Foldbelt, Pakistan. *Sindh Univ. Research Journal* (*Science Series*), **38**, 1-32.

[20] Malkani, M.S. (2007) Trackways Evidence of Sauropod Dinosaurs Confronted by a Theropod Found from Middle Jurassic Samana Suk Limestone of Pakistan. *Sindh University Research Journal* (*Science Series*), **39**, 1-14.

[21] Malkani, M.S. (2008) Marisaurus (Balochisauridae, Titanosauria) Remains from the Latest Cretaceous of Pakistan. *Sindh University Research Journal* (*Science Series*), **40**, 55-78.

[22] Malkani, M.S. (2009) New Balochisaurus (Balochisauridae, Titanosauria, Sauropoda) and Vitakridrinda (Theropoda) Remains from Pakistan. *Sindh University Research Journal* (*Science Series*), **41**, 65-92.

[23] Malkani, M.S. (2010) New Pakisaurus (Pakisauridae, Titanosauria, Sauropoda) re-Mains, and Cretaceous Tertiary (K-T) Boundary from Pakistan. *Sindh University Research Journal* (*Science Series*), **42**, 39-64.

[24] Malkani, M.S. (2010) Updated Stratigraphy and Mineral Potential of Sulaiman (Middle Indus) basin, Pakistan. *Sindh University Research Journal* (*Science Series*), **42**, 39-66.

[25] Sadiq Malkani, M. (2010) Osteoderms of Pakisauridae and Balochisauridae (Titanosauria, Sauropoda, Dinosauria) in Pakistan. *Journal of Earth Science*, **21**, 198-203. https://doi.org/10.1007/s12583-010-0212-z

[26] Sadiq Malkani, M. (2010) Vitakridrinda (Vitakrisauridae, Theropoda) from the Latest Cretaceous of Pakistan. *Journal of Earth Science*, **21**, 204-212. https://doi.org/10.1007/s12583-010-0213-y

[27] Malkani, M.S. (2014) Titanosaurian Sauropod Dinosaurs from the Latest Cretaceous of Pakistan. 2*nd Symposium of IGCP* 608 "*Cretaceous Ecosystem of Asia and Pacific*", Tokyo, 4-6 September 2014, 108-111.

[28] Malkani, M.S. (2015) Titanosaurian Sauropod Dinosaurs from Pakistan. In: Zhang, Y., Wu, S.Z. and Sun, G., Eds., *Abstract Volume*, 12*th Symposium on* "*Mesozoic Terrestrial Ecosystems* (*MTE* 12), *and* 3*rd Symposium of International Geoscience Program* (*IGCP* 608)" "*Cretaceous Ecosystem of Asia and Pacific*" *August* 15-20, 2015, Paleontological Museum of Liaoning/Shenyang Normal University, 93-98.

[29] Malkani, M.S. (2015) Dinosaurs, Mesoeucrocodiles, Pterosaurs, New Fauna and Flora from Pakistan. *Geological Survey of Pakistan*, *Quetta*, *Information Release*, **823**, 1-32.

[30] Malkani, M.S. and Sun, G. (2016) Fossil Biotas from Pakistan with Focus on Dinosaur Distributions and Discussion on Paleobiogeographic Evolution of Indo-Pak Peninsula. *Global Geology*, **19**, 230-240.

[31] Malkani, M.S. (2019) Recently Discovered Basilosaurid, Baluchithere Rhinoceros, Horses, Sea Cow, Proboscidean, Eucrocodile, Pterosaurs, Plesiosaur, Fishes, Invertebrates and Wood Fossils, Tracks and Trackways of Dinosaurs from Pakistan; Comparison of Recognized Four Titanosaur Taxa of Indo-Pakistan with Madagascar. *Open Journal of Geology*, **9**, 919-955. https://doi.org/10.4236/ojg.2019.912098

[32] Malkani, M.S. (2020) First Skull of Medium Sized Titanosaur in Indo-Pakistan Subcontinent Found from the Latest Maastrichtian Vitakri Formation of Pakistan; Associated Cranial and Postcranial Skeletons of *Gspsaurus Pakistani* (Poripuchia, Stocky

Titanosauria, Sauropoda) from Pakistan and India. *Open Journal of Geology*, **10**, 448-489. https://doi.org/10.4236/ojg.2020.104020

[33] Malkani, M.S. (2020) First Snout with Complete Teeth Row of Small Titanosaur in Indo-Pakistan Found from the Latest Maastrichtian Vitakri Formation of Pakistan; Associated Cranial and Postcranial Skeletons of *Saraikimasoom vitakri* (Poripuchia, Stocky Titanosauria, Sauropoda) from Pakistan and Referred Fossils from India. *Open Journal of Geology*, **10**, 368-407. https://doi.org/10.4236/ojg.2020.104018

[34] Malkani, M.S. (2020) *Pakisaurus Balochistani* (Poripuchia, Slender Titanosauria, Sauropoda) Associated Skeletons Found from the Latest Maastrichtian Vitakri Formation of Pakistan and Referred Fossils from India; Filling of Important Missing Links of *Isisaurus colberti* Titanosaur Found from Pakistan. *Open Journal of Geology*, **10**, 408-447. https://doi.org/10.4236/ojg.2020.104019

[35] Malkani, M.S. (2020) Theropods, Mesoeucrocodiles and Pterosaurs Found from the Latest Maastrichtian Vitakri Formation of Balochistan, Pakistan; Description with Large Photographs and Comparison with Coeval Taxa from Indo-Pakistan Subcontinent. *Open Journal of Geology*, **10**, 510-551. https://doi.org/10.4236/ojg.2020.105023

[36] Malkani, M.S. (2021) Jurassic-Cretaceous and Cretaceous-Paleogene Transitions and Mesozoic Vertebrates from Pakistan. *Open Journal of Geology*, **11**, 275-318. https://doi.org/10.4236/ojg.2021.118016

[37] Malkani, M.S. (2021) Formal Description of Mesozoic and Cenozoic Biotas Found from Pakistan. *Open Journal of Geology*, **11**, 411-455. https://doi.org/10.4236/ojg.2021.119023

[38] Malkani, M.S. (2022) Plates Boundary and Structural Geology of Balochistan and Indus Basins through Field Observations on Chaman Transform Fault and Western Indus Suture (Pakistan): Dinosaurs from Pakistan with Attributed Bones and Key Features: Titanosaurs from India with Updated Assessment on *Jainosaurus*. *Open Journal of Geology*, **12**, 1032-1079. https://doi.org/10.4236/ojg.2022.1211049

[39] Malkani, M.S. and Haroon, Y. (2022) Lithostratigraphy, Structure, Geological History, Economic Geology and Paleontology of Mari Bugti Hills and Surrounding Areas of Balochistan, South Punjab and North Sindh (Pakistan). *Open Journal of Geology*, **12**, 13-56. https://doi.org/10.4236/ojg.2022.121002

[40] Malkani, M.S., Ilyas, M., Yasin, R., Abbas, A., Samiullah, K., Raza, T., *et al.* (2022) Geology of Northern Sulaiman Foldbelt, Shirani and Waziristan Regions (South Punjab, Balochistan and Khyber Pakhtunkhwa): New Tomistominae (Miocene False Gharial) from Sakhi Sarwar Area of Dera Ghazi Khan (South Punjab), Pakistan. *Open Journal of Geology*, **12**, 521-564. https://doi.org/10.4236/ojg.2022.126025

[41] Malkani, M.S. (2023) Geology and Mineral Deposits of Saraikistan (South Punjab, Koh Sulaiman Range) of Pakistan: A Tabular Review of Recently Discovered Biotas from Pakistan and Paleobiogeographic Link: Phylogeny and Hypodigm of Poripuchian Titanosaurs from Indo-Pakistan. *Open Journal of Geology*, **13**, 900-958. https://doi.org/10.4236/ojg.2023.138040

[42] Malkani, M.S., Mantilla, J.A.W., Zalmout, I.S.A. and Gingerich, P.D. New Titanosaur Remains from the Vitakri Formation (Late Cretaceous) of Sangiali, Balo-chistan, Pakistan. Contributions from the Museum of Paleontology, The University of Michigan.

[43] Malkani, M.S., Muhammad, N. and Safi, A. (2025) Discovery of New Fossil Bones of Gigantic Dinosaur Found from the Kohat, Khyber Pakhtunkhwa, Pakistan. 1-30. https://www.researchgate.net/publication/395073756

[44] Malkani, M.S., Muhammad, N., Safi, A. (2025) Fossils of *Safisaur niazensis* Malkani 2025-the First Dicraeosaurid (*Flagellicaudata diplodocoidea*) Dinosaur from Kohat Area of Khyber Pakhtunkhwa Province (Pakistan). 1-13. https://www.researchgate.net/publication/395555338

[45] Malkani, M.S. (2025). First Dicraeosauridae (Diplodocoidea) Dinosaur from Pakistan: First Dinosaur from Khyber Pakhtunkhwa Province of Pakistan. 1-31. https://www.researchgate.net/publication/395304217

[46] Safi, A. and Karl, H. (2024) A Review on the Updated Checklists of the Amphibians and Reptiles of Pakistan: Present and Prehistoric. *Journal of Biodiversity and Biotechnology*, **4**, 22-37. https://doi.org/10.20961/jbb.v4i1.106964

[47] Karl, H.V., Safi, A. and Tichy, G. (2024) Review of Fossil Records of Prehistoric Reptiles, Their Distribution, and Paleobiogeographic Evolution in Pakistan. *Scientific Reports in Life Sciences*, **5**, 1-23.

[48] Karl, H.V., Safi, A. and Tichy, G. (2025) A Review of the Dinosaurs of the Late Jurassic-Early Cretaceous from Present Day Pakistan. *Scientific Reports in Life Sciences*, **6**, 61-85. https://doi.org/10.5281/zenodo.16895340

[49] Malkani M.S. and Somro, N. (2025) Petroleum and Mineral Resources, Water and Agricultural Resources of Rajanpur District (South Punjab, Pakistan). *International Conference on* "*Sustainable Utilization of Natural Resources*", Peshawar, 19-20 February 2025, 1-2.

[50] Tariq M., Malkani, M.S., Qureshi, I.H. and Ahmed, S.A. (1993) Geology of Shirinab (Quadrangle 34 K/10,) Mastung and Kalat Districts, Balochistan, Pakistan. Geological Survey of Pakistan, 543.

[51] Malkani, M.S. (2025) Ophiolites of Pakistan: Their Mineral Resources. 4*th International Conference on* "*Sustainable Utilization of Natural Resources*", Peshawar, 19-20 February 2025, 3-4.

[52] Ilyas, M. and Fazal, R.M. (2025) New Material of Late Miocene *Indarctos* (Carnivora, Mammalia) from the Koh-Sulaiman Range, South Punjab, Pakistan. *Historical Biology*, **37**, 1850-1858. https://doi.org/10.1080/08912963.2025.2458116

[53] Huene, F.V. and Matley, C.A. (1933) Cretaceous Saurischia and Ornithischia of the Central Provinces of India. *Paleontologia Indica*, **21**, 1-74.

[54] Jain, S.L. and Bandyopadhyay, S. (1997) New Titanosaurid (Dinosauria: Sauropoda) from the Late Cretaceous of Central India. *Journal of Vertebrate Paleontology*, **17**, 114-136. https://doi.org/10.1080/02724634.1997.10010958

[55] Hunt, A.P., Lockley, M.G., Lucas, S.G. and Meyer, C.A. (1994) The Global Sauropod Fossil Record. *GAIA*, **10**, 261-279.

[56] Wilson, J.A., Barrett, P.M. and Carrano, M.T. (2011) An Associated Partial Skeleton of *Jainosaurus* cf. *Septentrionalis* (Dinosauria: Sauropoda) from the Late Cretaceous of Chhota Simla, Central India. *Palaeontology*, **54**, 981-998. https://doi.org/10.1111/j.1475-4983.2011.01087.x

[57] Mathur, U.B. and Pant, S.C. (1986) Sauropod Dinosaur Humeri from Lameta Group (Upper Cretaceous-? Palaeocene) of Kheda District, Gujarat. *Journal of the Palaeontological Society of India*, **31**, 22-25. https://doi.org/10.1177/0552936019860104

[58] Hocknull, S.A., White, M.A., Tischler, T.R., Cook, A.G., Calleja, N.D., Sloan, T., *et al.* (2009) New Mid-Cretaceous (Latest Albian) Dinosaurs from Winton, Queensland, Australia. *PLOS ONE*, **4**, e6190. https://doi.org/10.1371/journal.pone.0006190

[59] Poropat, S.F., Upchurch, P., Mannion, P.D., Hocknull, S.A., Kear, B.P., Sloan, T., *et al.* (2015) Revision of the Sauropod Dinosaur *Diamantinasaurus matildae* Hocknull

et al. 2009 from the Mid-Cretaceous of Australia: Implications for Gondwanan Titanosauriform Dispersal. *Gondwana Research*, **27**, 995-1033. https://doi.org/10.1016/j.gr.2014.03.014

[60] Rigby, S.L., Poropat, S.F., Mannion, P.D., Pentland, A.H., Sloan, T., Rumbold, S.J., *et al.* (2021) A Juvenile *Diamantinasaurus matildae* (Dinosauria: Titanosauria) from the Upper Cretaceous Winton Formation of Queensland, Australia, with Implications for Sauropod Ontogeny. *Journal of Vertebrate Paleontology*, **41**, e2047991. https://doi.org/10.1080/02724634.2021.2047991

[61] Rogers, K.C. (2009) The Postcranial Osteology of *Rapetosaurus krausei* (Sauropoda: Titanosauria) from the Late Cretaceous of Madagascar. *Journal of Vertebrate Paleontology*, **29**, 1046-1086. https://doi.org/10.1671/039.029.0432

[62] Sallam, H.M., Gorscak, E., O'Connor, P.M., El-Dawoudi, I.A., El-Sayed, S., Saber, S., *et al.* (2018) New Egyptian Sauropod Reveals Late Cretaceous Dinosaur Dispersal between Europe and Africa. *Nature Ecology & Evolution*, **2**, 445-451. https://doi.org/10.1038/s41559-017-0455-5

[63] Rogers, K.C. and Forster, C.A. (2004) The Skull of *Rapetosaurus krausei* (Sauropoda: Titanosauria) from the Late Cretaceous of Madagascar. *Journal of Vertebrate Paleontology*, **24**, 121-144. https://doi.org/10.1671/a1109-10

[64] Kurzanov, S.M. and Bannikov, A.F. (1983) A New Sauropod from the Upper Cretaceous of Mongolia. *Paleontological Journal*, **2**, 90-96.

[65] Chatterjee, S. and Rudra, D.K. (1996) KT Events in India: Impact, Rifting, Volcanism and Dinosaur Extinction. *Memoir of the Queensland Museum*, **39**, 489-532.

[66] Berman, D.S. and Jain, S.L. (1982) The Braincase of a Small Sauropod Dinosaur (Reptilia: Saurischia) from the Upper Cretaceous Lameta Group, Central India, with Review of Lameta Group Localities. *Annals of the Carnegie Museum*, **51**, 405-422. https://doi.org/10.5962/p.330752

[67] Von Huene, F. (1929) Los saurisquios y ornithisquios del Creta'ceo Argentino. *Anales del Museo de La Plata*, **2**, 1-196.

[68] Nowinski, A. (1971) Nemegtosaurus mongoliensis n. gen. n. sp. (Sauropoda) from the uppermost Cretaceous of Mongolia. *Palaeontologica Polonica*, **25**, 57-81.

[69] Wilson, J.A. (2005) Redescription of the Mongolian Sauropod *Nemegtosaurus mongoliensis* Nowinski (Dinosauria: Saurischia) and Comments on Late Cretaceous Sauropod Diversity. *Journal of Systematic Palaeontology*, **3**, 283-318. https://doi.org/10.1017/s1477201905001628

[70] Gomani, E.M. (2005) Sauropod Dinosaurs from the Early Cretaceous of Malawi, Africa. Palaeontologia Electronica, 1-37. http://palaeo-electronica.org

[71] Powell, J.E. (2003) Revision of South American *Titanosaurids dinosaurs*: Palaeobiological, Palaeobiogeographical and Phylogenitic Aspects. *Records of the Queen Victoria Museum*, **111**, 1-173.

[72] Swinton, W.E. (1947) VIII.—New Discoveries of *Titanosaurus indicus* Lyd. *Annals and Magazine of Natural History*, **14**, 112-123. https://doi.org/10.1080/00222934708654616

[73] Bajpai, S., Datta, D., Pandey, P., Ghosh, T., Kumar, K. and Bhattacharya, D. (2023) Fossils of the Oldest Diplodocoid Dinosaur Suggest India Was a Major Centre for Neosauropod Radiation. *Scientific Reports*, **13**, Article No. 12680. https://doi.org/10.1038/s41598-023-39759-2

[74] Coria, R.A., Windholz, G.J., Ortega, F. and Currie, P.J. (2019) A New Dicraeosaurid Sauropod from the Lower Cretaceous (Mulichinco Formation, Valanginian, Neuquén

Basin) of Argentina. *Cretaceous Research*, **93**, 33-48. https://doi.org/10.1016/j.cretres.2018.08.019

[75] Rauhut, O.W.M., Remes, K., Fechner, R., Cladera, G. and Puerta, P. (2005) Discovery of a Short-Necked Sauropod Dinosaur from the Late Jurassic Period of Patagonia. *Nature*, **435**, 670-672. https://doi.org/10.1038/nature03623

[76] Harris, J.D. and Dodson, P. (2004) A New Diplodocoid Sauropod Dinosaur from the Upper Jurassic Morrison Formation of Montana, USA. *Acta Palaeontologica Polonica*, **49**, 197-210.

[77] Harris, J.D. (2006) The Axial Skeleton of the Dinosaur *Suuwassea emilieae* (Sauropoda: Flagellicaudata) from the Upper Jurassic Morrison Formation of Montana, USA. *Palaeontology*, **49**, 1091-1121. https://doi.org/10.1111/j.1475-4983.2006.00577.x

[78] Woodruff, D.C. and Fowler, D.W. (2012) Ontogenetic Influence on Neural Spine Bifurcation in Diplodocoidea (Dinosauria: Sauropoda): A Critical Phylogenetic Character. *Journal of Morphology*, **273**, 754-764. https://doi.org/10.1002/jmor.20021

[79] Hatcher, J.B. (1901) Diplodocus (Marsh): Its Osteology, Taxonomy, and Probable Habits, with a Restoration of the Skeleton. *Memoirs of the Carnegie Museum*, **1**, 1-63. https://doi.org/10.5962/p.234818

[80] Ibiricu, L.M., Casal, G.A., Lamanna, M.C., Martínez, R.D., Harris, J.D. and Lacovara, K.J. (2012) The Southernmost Records of Rebbachisauridae (Sauropoda: Diplodocoidea), from Early Late Cretaceous Deposits in Central Patagonia. *Cretaceous Research*, **34**, 220-232. https://doi.org/10.1016/j.cretres.2011.11.003

[81] Salgado, L. and Bonaparte, J.F. (1991) Un nuevo sauropodo Dicraeosauridae Amargasaurus cazaui gen. et sp. nov. de la Formation La Amarga, Neoconiano de la provinciadel Neuquen, Argentina. *Ameghiniana*, **28**, 333-346.

[82] Janensch, W. (1914) Ubersicht uber die Werbeltierfauna der tendaguruschichten nebsteiner kurzenCharakterisierung der neu aufgefuhrten Arten von Sauropoden. *Archiv fur Biontologie*, **3**, 81-110.

[83] Sahni, A. (2001) Dinosaurs of India. National Book Trust, 110.

[84] Upchurch, P. and Mannion, P.D. (2009) The First Diplodocid from Asia and Its Implications for the Evolutionary History of Sauropod Dinosaurs. *Palaeontology*, **52**, 1195-1207. https://doi.org/10.1111/j.1475-4983.2009.00909.x

[85] Whitlock, J.A., D'Emic, M.D. and Wilson, J.A. (2011) Cretaceous Diplodocids in Asia? Re-Evaluating the Phylogenetic Affinities of a Fragmentary Specimen. *Palaeontology*, **54**, 351-364. https://doi.org/10.1111/j.1475-4983.2010.01029.x