Open Journal of Geology, 2023, 13, 1069-1138
https://www.scirp.org/journal/ojg
ISSN Online: 2161-7589
ISSN Print: 2161-7570

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

Muhammad Sadiq Malkani

Geological Survey of Pakistan, Muzaffarabad, Pakistan
Email: malkanims@yahoo.com

How to cite this paper: 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

Received: September 13, 2023
Accepted: October 23, 2023
Published: October 26, 2023

Abstract

Indus basin hosts many significant mineral deposits like gypsum and cement raw materials, gemstones, iron, coal, marble, dimension and construction stones, petroleum and water resources, world class pink salt and other many minerals in different regions which need further exploitation and development. The construction of new water dams in different regions are vital (for availability of cheap electricity), because of available barren and fertile lands and wastage of water as flood. Further the installation of more cement industries in different regions of Indus Basin especially in middle Indus (Sulaiman Range where gypsum, clays and limestones can be available via belt) can increase export to receive more foreign exchange and make local cement cheap for the sustainable development of Pakistan. 31 stratigraphic sequential sections at different sections of Indus basins are presented to know the variation and local stratigraphy. Further here three new titanosaur taxa are being described. *Saraikimasoom* is based on snout; *Gspsaurus*, (*Maojandino*), *Nicksaurus* and *Khanazeem* are based on cranial, vertebral and appendicular elements; *Balochisaurus*, *Marisaurus*, *Pakisaurus,* and 3 new genera and species *Imrankhanhero zilefatmi, Qaikshaheen masoomniazi* and *Ikqaumishan smqureshi* based on vertebral and appendicular elements; and *Sulaimanisaurus* and *Khetranisaurus* based on only caudal vertebrae. Although Pakistani Titanosaurians seem to be proliferated found from one horizon of Vitakri Formation just below the K-Pg boundary they have a wide range of diagnostic features and key elements among titanosaurs which can be used for comparison and phylogenetic analyses with broad updated character data set of titanosaurs.

Keywords

Mineral Deposits, Stratigraphic Sequences, Structures, Multiple Sections, Indus Super Basin, New Titanosaurs, Latest Maastrichtian, Vitakri Formation, Pakistan

1. Introduction

Indus basin covers more than half of Pakistan. It is divided into upper (including the upper and uppermost part), middle and lower Indus Basins (**Figure 1**). Mineral resources of Pakistan were reported by many workers since 1954 [1] [2] [3] [4] and more recently reported by [5] [6] [7]. Mineral resources of upper Indus basin [8]-[17] with coal [18] [19] [20], middle Indus basin [21]-[27] with fluorite [28] [29], gypsum [6] [7] [21] [22] [30], barite [31] and Chamalang coal [32] [33], and lower Indus [23] [34] [35] [36] [37] [38] basin with fluorite [39] were presented. Minerals on the western contact with Balochistan Basin are also presented [40] [41]. Here a glance on the mineral resources of different parts of Indus basin is presented. Stratigraphy of the western part of Pakistan was reported in 1961 [42] while stratigraphy of Pakistan was reported by many early workers [43] [44] [45] [46] [47] [48] and more recently reported in 2016-17 [49] [50]. Further, the stratigraphy of different parts of the upper Indus Basin [15] [49] [50] [51], middle Indus Basin [21]-[27] including Mari Bugti hills [25] and northern and eastern Sulaiman [26] [27] and lower Indus basin [35] [36] [52] were reported. Here stratigraphic sequential variations (north to south and east to west) with the help of 31 different sections in different parts of Indus basin are being presented. Work on dinosaur fossils in India has been continuing since the last two centuries [53]. Dinosaur bone was first time reported in Pakistan in early 2000 [54]. Later on, around about 3 thousand fossils were collected. First-time *Pakisaurus, Sulaimanisaurus, Khetranisaurus, Balochisaurus* and *Marisaurus* [55] [56] [57] [58] in 2004 were informally described. Second-time *Gspsaurus, Saraikimasoom, Nicksaurus* and *Maojandino* [59] [60] [61] [62] [63] in 2014 were informally described. *Gspsaurus, Saraikimasoom, Pakisaurus, Sulaimanisaurus* and *Khetranisaurus* [51], and *Balochisaurus, Nicksaurus*, *Maojandino* and *Marisaurus* [64] were formally described in 2021 as per the standard set by the International Code of Zoological Nomenclature (ICZN). Third-time *Khanazeem* [52] was described in 2022 and now the fourth time in 2023 the three new titanosaurian sauropods are being described. Most of these titanosaurian sauropods provide a facility for comparison based on key cranial, humeri, femora, tibia and other limb bones because presacral vertebrae are not common and caudal series variations are challenging [65]. Besides the titanosaurs, 3 theropods (*Vitakridrinda sulaimani* [51] [55] [56] [66], *Vitakrisaurus saraiki* [21] [51] [66] and *Shansaraiki insafi* [27] [52]), mesoeucrocodiles (*Pabwehshi pakistanensis* [67], *Induszalim bala* [51] [68], *Sulaimanisuchus kinwai* [21] [51] [66] and *Mithasaraikistan ikniazi* [51]), pterosaurs (*Saraikisaurus minhui* [51] [69] and *Imrankhanuqab qaeddiljani* [27]), large snake (*Wadanaang kohsulaimani* [51]), bird (*Wasaibpanchi damani* [51] [64]) and poorly preserved fossil of mammal (*Mirvitakriharan haji* [64]) found from the Vitakri Formation [70] at Vitakri dome localities [51] [64] [70]. The titanosaurian osteoderms from Asia were first reported from Pakistan in 2003 [71] [72]. Many preCretaceous and postCretaceous recently discovered biotas were also described ([51] [57] [60] [61] [63] [73] and references therein). Less and More wide-gauge locomotions of titanosaurian are also presented [27] [74]. Footprints and trackways of Mesozoic archosaurs were also discovered ([51] [57] [59] [64] [74] [75] [76] and references therein). A few fossils from India [77] [78] [79] are being referred to as titanosaur taxa (see below) from Pakistan.

Institutional Abbreviations: GSP, Geological Survey of Pakistan, Quetta, Pakistan.

UM, Museum of Paleontology, University of Michigan, USA.

2. Materials and Methods

The materials belong to previous work and field data collected during multiple field visits done during many field seasons. The observations and field data were collected for a glimpse of mineral deposits of different portions and stratigraphic horizons at different sections and also folded structures, especially anticlines. The fossils were collected from many localities in the Vitakri Formation since 2000 from Pakistan. The methods applied here are many disciplines of pure geology, stratigraphic and structural procedures and diagnosis, comparison and description of paleontological fossils.

3. Results and Discussion

Here the results and discussion are represented in the three major subjects. The first major subject is a glance at mineral deposits of different parts of Indus Basin of Pakistan. The second major subject is the stratigraphic sequence variations and structural description at different sections in the upper, middle and lower Indus basins. The third major subject is a description of new titanosaurian sauropod dinosaurs from the latest Maastrichtian Vitakri Formation of Central Pakistan.

3.1. A Glance on the Mineral Deposits of Indus Basin of Pakistan

Indus Basin is a large area that is divided into different basins and further into different regions (**Figure 1**). Here a glance at mineral deposits of different parts of the Indus basin (**Figure 2**) is presented along with references for detailed investigations. The upper Indus Basin includes the Azad Kashmir, part of Gilgit Baltistan, Khyber Pakhtunkhwa and Islamabad and North Punjab. The gemstones of Gilgit-Baltistan Province are famous worldwide and also include marble, copper,

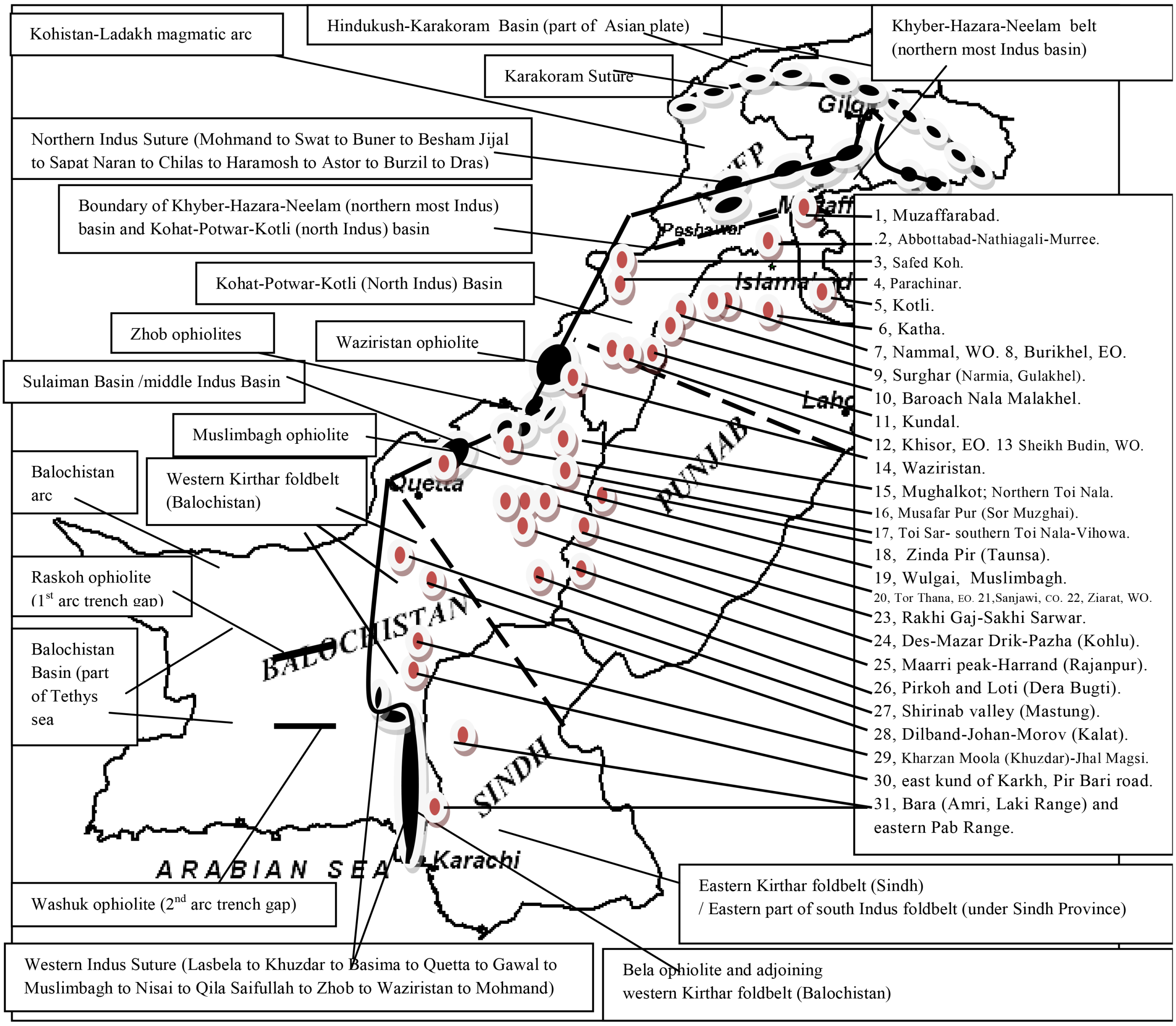

Figure 1. Map of Pakistan showing different basins and their subdivision. Indus basin and its division into upper, middle and lower Indus basins and further subdivision into different regions are also shown. Red oval represents the location of stratigraphic sections taken from different parts of Indus Basin. Abbreviation, EO, Eastern oval. CO, Central Oval. WO, Western Oval.

dimension and construction materials and many other minerals can be seen in [5]-[20]. The Azad Kashmir includes bauxite, laterite and ochre from Muzaffarabad, Kotli and Reshian regions (disconformity); copper, gossans/red iron oxide/ochre and graphite from Neelam river; sheet mica/muscovite and lithium mica/lipedolite from many pegmatites of Neelam valley; uranium in graphitic schist of Precambrian Salkhala Formation found in Reshian region ESE of Muzaffarabad; nepheline syenite from Reshian region, coal from Kotli region and limestone and marble from different areas. The reserves of bauxite, laterite and ochre are Dhanwan is 4.9 mt, Kamroti is 1.36 mt, Sawar is 0.93 mt, Dandili is 1.18 mt, Nikial is 0.424 mt, Goi is 1.103 mt, Shisetar is 0.656 mt, Bermoach is 0.2 mt, Balmi is 0.209 mt, Khandar Karela is 0.209 mt and Palan is 0.283 mt with total 11.454 mt. Azad Kashmir represents many gemstones from Neelam valley

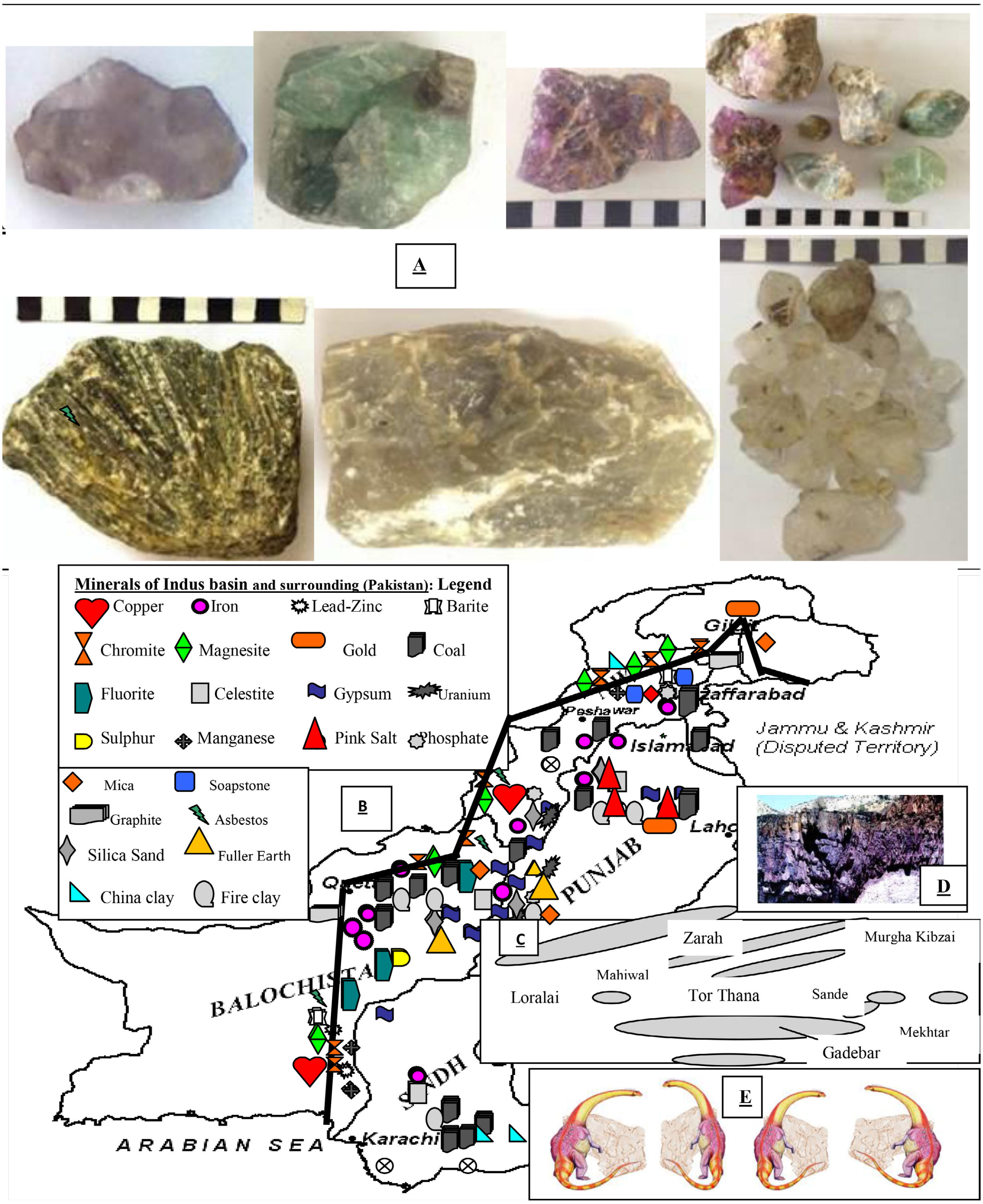

Figure 2. (A) upper row fluorite from Loralai and surroundings (Loralai and Zhob Districts) and Moola Zahri Range (Khuzdar District), lower row barite from Mekhtar (Loralai), celestite (Barkhan) and Kingri Diamond-quartz (Musakhel District, Balochistan) from the middle and lower Indus fold belts. (B) Minerals of the Indus Basin and surrounding (Pakistan). A thick black line indicates the western Indus Suture (in the west) and northern Indus suture (in the north). (C) Jurassic Loralai Limestone forming anticline (grey ovals) hosts fluorite deposits. (D) Dilband iron from Johan area, Kalat. (E) models of *Qaikshaheen*, *Imrankhanhero, Khanazeem* and *Ikqaumishan* dinosaurs managed by British Journalist Mr. Nicholas Allen and prepared by Russian Paleoartist Dr. Dmitry Bogdanov.

like orange-red spessartine garnet (large crystals) in pegmatites, ruby from Nangimali-Khora-Katha-Chita Ratta and Naril Nala areas in meta limestone and calcite veins, green tourmaline from Donga Nar pegmatites, black tourmaline (schorl) and quartz from different gem localities [5]-[20]. Gypsum up to 20 m thick (more than 2 million tons up to 200 m depth) is observed in Hazara slates (**Figure 3**) from east of Thandiani (Nathiagali) and continues upto Muzaffarabad. Gypsum is also observed in Reshian-Neelam Valley (about 1 million tons) in the Salkhala Formation. Gypsum is soft, laminated to thick-bedded and massive. 1 - 2 m limonitic ferruginous beds occur at the base of Hazara Gypsum (east of Thandiani), and 1 - 2 m ferruginous carbonaceous shale/graphite observed at the base of Salkhala gypsum deposits (Reshian Valley, just southeast of Reshian village), and in Bela Pir area this disconformable bed include micaceous hematite formed by tectonic heat, all these show uplift of area and then evaporitic deposition resulted as gypsum beds. These evaporitic facies provide a facility to correlate with the Precambrian Salt Range, Hazara and Salkhala Formations. Now Hazara is a commonly used name for Salkhala slates. The hot water spring at Tatta Pani is found in a thrusted fault of more than 70˚ eastward dip in Abbottabad Dolomite. Nearby locals use this hot water spring for baths, especially in winter, however it can be used for room heating during winter.

Economic geology and mineral commodities of the Murree to Nathiagali to Abbottabad road section (**Figure 2**) (**Figure 4**) represent some glauconitic, chamositic and lateritic iron beds of Cretaceous Chichali Formation (especially at Galdanian and north of Thandiani) and Latest Cretaceous to Early Paleocene Hangu Formation, and coal deposits (in Harnoi and Kali Mati areas) (**Figure 4**) of Latest Cretaceous to Early Paleocene Hangu Formation of Abbottabad District, Hazara. Further huge building stone/construction materials and cement resources like the limestone and dolomitic limestone of Abbottabad, Samanasuk, Kawagarh, Lockhart/Margala Hill/Sakesar formations are found in the area. The other cement resources ingredients like clays can be found in Chichali and Nammal formations in the section while gypsum is found in the Hazara Formation of the eastern vicinity of the section. Phosphate, soapstone, iron, barite and gypsum are found in the vicinity areas of section [5] [6] [7] [10] [18] [19].

Khyber Pakhtunkhwa area (**Figure 2**) has high potential of minerals/rocks like coal, precious gem minerals like emerald, aquamarine, fluorite, garnet, moonstone, pargasite, peridot, quartz, ruby, spinel, kyanite, topaz (pink topaz), tourmaline and others, indigenous iron, copper, gold, lead, zinc, chromite, radioactive minerals, rock phosphate, gypsum, rock salt, laterite and ochre, silica sand, granite, quartzite, nepheline syenite, natural gas and oil, limestone, marble, slatstone, serpentine, sandstone, gravel, sand, silt and different type of clays, etc, and low potential of antimony, asbestos, barite, fluorite, magnesite, soapstone, bauxite, mica, feldspar, graphite, potash salt, arsenic, tungsten, platinum group, nickel, cobalt, vanadium, thorium, Rubidium, Rare metals (Nb, La, Y, V and etc.), and Rare Earth elements (Ce, Nd, Pr, Sm, Gd) [5] [6] [7] [10] [11] [12] [13] [14]

[18] [19]. The extension of coal into Tarah area [80] of Khyber Agency is encouraging to increase in coal and energy resources.

Islamabad has some construction stone resources such as Sakesar Limestone (Margala Hill Limestone). This area also needs small dams construction to preserve rainwater resources which are wasted as flood. North Punjab has minerals/rocks like indigenous iron, radioactive minerals, coal, gypsum, celestite, rock salt (especially exportable high-quality pink salt), potash salt laterite/bauxite, ochre, silica sand, petroleum, dolomite, gemstones, dimension stones/limestone (marble), construction stones, sandstone, gravel, sand, silt and different type of clays [5] [6] [7] [10] [18] [19]. Pink salt (**Figure 5**) is very significant (like gold) for export and earning foreign exchange. Burekhel Permian coal section is shown in (**Figure 4**).

The middle Indus/Sulaiman Basin (**Figure 1**, **Figure 2**, **Figures 6-8**) falls under the territory of South Punjab, Khyber Pakhtunkhwa and Balochistan. The minerals of Khyber Pakhtunkhwa are mentioned above and its detail is found in [5] [6] [7] [10] [18] [19]. Balochistan Province (the eastern part belongs to the middle and lower Indus basins) has large proven reserves of indigenous iron, copper (associated with some gold, silver, and molybdenum), lead, zinc, barite, chromite, coal, gypsum, limestone (marble), ochre, silica sand, etc, small deposits of antimony, asbestos, celestite, fluorite, magnesite, soapstone, sulphur, vermiculite, pyrite (in the shale of different Formation especially in Chagai arc, western Indus suture and 3m thick pyritic limestone exposed in Chotok stream of Moola Zahri Range). Some commodities are being utilized and some are being exported but most of the commodities are waiting for their utilization and development. Cement raw materials are common and also in one place, so the installation of more cement industries can help greatly for the country's economy by exporting. Further water resources are too much and water is going into the sea creating flood and loss in the agricultural lands and population, so smaller dams are necessary due to population increasing. The first and huge gypsum deposits of Pakistan are found in Sulaiman fold belt of Balochistan but not utilized. Coal production is 58% of the country is from Balochistan [5] [6] [7] [10] [18]-[34].

South Punjab (Taunsa, Dera Ghazi Khan and Rajanpur districts) has many minerals [5] [6] [7] [10] [18]-[34] like vast cement resources like limestone (Fort Munro and Dungan limestones, Eocene limestones and marl), huge gypsum from Baska Formation and shales from Shaheed Ghat, Domanda and Drazinda formations and Vihowa group, construction, dimension and decor stones from alluvium and also from bed rocks, various types of clay deposits like bentonite, fuller's earth and fire clay, surface and groundwater resources, uranium, petroleum, coal and carbonaceous shales, hot springs (Garmaf and Zinda Pir Ziarat) and many other minerals like abrasives from gritty Pab sandstones and millstones from hard Pab sandstones. The Rakhi Gaj area shows nodules with 5% - 20% P_2O_5 and Zinda Pir area shows 5% P_2O_5 reported from Sangiali group (Sangiali, Rakhi Gaj and Dungan formations especially green and black shale and muddy strata) and Shaheed Ghat shale. The phosphatic nodules with 5% P_2O_5 were reported in Domanda and Drazinda shales. Phosphate nodules are found in about 20 m shale horizon of Rakhi Gaj Formation. Agromineral resources like phosphate showings and alum shales are encouraging further exploration because South Punjab is agricultural centre of Pakistan. The possible low-grade but large deposits of ochre/iron (may contain aluminum) found from Chitarwata, Vihowa, Rakhi Gaj, Vitakri and Drazinda formations may be used for paint and abrasive and other purposes. The celestite mineral showings are found in the Eocene limestone of D.G.Khan, Taunsa and Rajan Pur districts of South Punjab. The heavy and resistant minerals like ilmenite, magnetite, gold, scheelite, rutile, zircon, monazite (REE-bearing), gold, etc and many gemstones and jewelry resources found easily in placer deposits of Indus River and Oligocene to recent alluvial deposits. The beautiful detritial pebbles and cobbles, amorphous or chalcedonic silica like chert, flint, jasper, etc, found in the conglomerate and gritty sandstone of Oligocene Chitarwata, Miocene Vihowa and Litra and Pliocene Chaudhwan formations of Vihowa Group and Pleistocene Dada and Holocene Sakhi Sarwar formations of Sakhi Sarwar Group and recent river and flood plain areas. Low-grade iron deposits (Fe_2 O_3 14% - 21%) found as ferruginous sandstone with minor shale in Girdu (Gorge beds) member of Rakhi Gaj formation of Khar Fort Munro, Top Girdu, Mian Ghundi, Rakhi Gaj, Bawata, Kingri, Badhi, Chitri areas. Greenish grey and red spotted and red wavy laminated sandstone show iron (along with phosphate) mineralizations and bivalve shell of Rakhi Gaj Formation. Hematite and possibly hydrous iron silicates (chamosite and glauconite) are major iron mineralization and may be derived from Deccan volcanism. Its testing for steel, cement and other industries should be made and may prove worthy. Extensive iron bed thickness varies from 2 to 50 meter/m. Its reserves seem to be 400 million tons from surface exposure to easily mineable depth 200 m. Its mining is easy due to exposure above the ground surface, and at places low dips. The Fort Munro iron deposits seems to be favorable due to the availability of huge but low-grade raw materials, open pit mining, locations on the metalled road and near to D.G.Khan railway station, central Pakistan [5] [6] [7] [27].

The lower Indus basin falls under the territory of Sindh and Balochistan provinces.

The mineral resources of Balochistan Province can be seen as above and also with detail in [5] [6] [7] [10] [18]-[34]. The Sindh Province includes Kirthar Basin and the southeastern part of Sulaiman Basin. Iron, laterite and ochre were reported from Lakhra, Meting and Makli hills, Nagar Parker, Jhal Dhand, Sohnari Dhand and Noriabad; Nari Formation and in Manchar/Vihowa group in the eastern Kirthar fold belt; celestite from Thano Bula Khan; tungsten/scheelite, gold and other heavy mineral concentrates (magnetite, ilmenite, garnet, epidote, zircon, tourmaline, amphibole/hornblende and tremolite, apatite, pyroxene, etc) from placer in the Indus River and mollase rocks like Vihowa group, Manchar group and recent sea; zircon from the shore areas, gold (can be explored) from Nagar Parker; alum from pyritiferous shales of Gajbeds from Maki Nai, shales of Ranikot group and Nari/Gaj group and at Shah Hassan near Trimi. Alum, Trona (source of Na) and potash slats associated with rock salt deposits and lakes in the vicinity of Sind coast; gypsum from Miocene Gaj shales near Johi and K.N.Shah, Dadu district and nitrogen from air. Various Ceramic Mineral Resources/clays found from Laki, Kirthar and Vihowa/Manchar groups; China clay from Nagar Parkar and Islamkot Thar, Dhed Vero, Parodhoro, Karkhi, Dungri, Motijo, Vandio, Ramji-jo-Vandio, and Didwa-Surachand areas; fuller's earth from Thano Bulla Khan (Dadu district) and Shadi Shahid (Khairpur; near Jheruk and Rohri and at Begamji; fire clay from Dadu district, Sohnari Dhand/Jhimpir; Laki group, Ranikot group and Vihowa/Manchar group of eastern Kirthar Foldbelt; orthoclase feldspar from Nagar Parkar; silica sand from Meting to Jhimpir railway stations and in Eocene and Oligocene strata near Thano Bula Khan in Dadu district and Jangshahi deposits; cement industry raw materials and calcite veins in limestone of different age; pyrite is disseminated in carbonaceous shale and coal; abrasives type red ochre in Eocene Sohnari beds, nodular flints between Rohri and Kot diji; in west of Jhol Dhaund, around Harmon Mohatta coal mine west of Sohnari Dhand (west of Jhimpir), west of Ongar Jhol Dhand (north of Thatta) and Sohnari 15 km east of Jhimpir; Grity Pab sandstone of Khadro and Bara areas (can be used for abrasive purposes); Quartz deposits of Cretaceous Pab Formation from eastern slope of Lakhi range district Dadu; Radioactive Mineral/uranium Resources from fluviatile cross bedded sandstones/placer of Vihowa/Manchar group; Coal Resources from Thar, Lakhra, Badin, Sonda-Thatta, Meting-Jhimpir; large Construction stone, dolomite and Industrial rocks Resources from Jurassic to Eocene sequences in Kirthar and Lakhi ranges, Thar and Cholistan desert; granite and other Igneous along with some metamorphic rocks from Nagar Parker, large Water resources in alluvial and bed rocks, and gemstone like agate and chalcedony from Nagar parker, chert, flint and Jasper from Vihowa group/Manchar group from eastern Kirthar and Lakhi range and other areas. Natural Resources like minerals, coal, oil, natural gas, etc are non-renewable resources while solar, air/wind, terrestrial water, marine water/ocean, tides, waves, current, land, biomass, etc are renewable (recycled) resources. It is our urgent need to convert the non-conventional energy resources into conventional energy resources. Our land is receiving huge amounts of energy from the sun. The coastal areas have high potential for wind energy. The gravitational force of the moon produces tidal energy in sea which can be converted in energy by the construction of dams that can store water at high tides and release water at low tides. Sindh has a long seashore from Nagar Parker to the west of Karachi. Energy from sea waves can also benefit from stable and non-stable plate movements. Sindh also has a large waste biomass [5] [6] [7] [35] [36] [37].

Dilband-Johan ironstone and their extension: During 1990-91 the author

(MSM) and Masud Tariq started mapping Shirinab-Khad Kucha and its surroundings under the GSP mapping and mineral investigation Project. We found an ironstone pocket in the mountain range located just east of Khad Kucha Tehsil office. Further in the east, we found Johan ironstone (**Figure 9**) now commonly called Dilband-Johan iron or Dilband iron in the Johan area, stratigraphically in the Dilband ironstone (**Figure 9**) (lower Sembar Formation) just above the Jurassic Chiltan Limestone). We got samples from these ironstones and analyzed them from the chemistry Lab, GSP, Quetta. The chemical results of iron stone from Johan Area show Fe_2O_3 56.01% to 69.75% and eastern Khad Kucha small lenticular pocket shows Fe_2O_3 24.79% (**Table 1**). Our report on Geology of Shirinab Valley and its surroundings shows Permo-Jurassic to Subrecent and Recent strata, as structural and economic geology of the area [81]. The iron percentage up to 69.75 shows sampling from good ironstone bed, while the numerous samples collected by [82] show average iron percentage with also impurities. Later on the reference [82] worked on Dilband and Johan ironstone deposits and conveyed reserves. Here besides reserves and chemical analyses, its extension is also mentioned. Dilband ironstone deposits are located in the Koh Dilband and surrounding areas, accessible 20 Km/kilometer northeast of Johan village and 100 Km from Mastung town and Kolpur railway station. Dilband and the surrounding area is a broad anticlinorium. The ironstone consists of hematite (and minor limonite) with calcite, quartz and chlorite. The overall reserves are estimated at about 340 million tons/mt which includes proved reserves of 200 mt and indicated/inferred reserves 140 mt with an average 35% - 48% Fe_2O_3. Ironstone found in the Latest Jurassic (150 - 145 Mya) Dilband Formation (5 - 30 m) which is an uppermost member of the Triassic-Jurassic Sulaiman Group. Dilband Formation (30 m thick in type area) shows lower grey to brown and white Jarositic clay, middle reddish ironstone and upper green glauconitic shale. This oolitic-pisolitic ironstone exposed in Dashtari, Hoshi-Sabrin, Gorjat, Gorjat Nala and Dilband-Shikarap localities varies in thickness from 0.75 m (in Dilband) to 5 m (in Gorjat Nala). Dashtari ironstone 23 samples show Fe_2O_3 47.25% - 68.67%, SiO_2 12.57% - 29.88%, P_2O_5 0.1 - 1.0, TiO_2 traces-0.5%, Al_2O_3 2.14% - 9.89%, CaO 1.4% - 11.21%, MgO traces to 6.91%, S traces-1.66% and LOI 7.02% - 16.95%. Proved iron ore reserves of Dashtari area are 40.50 mt based on an average 2.5 m thickness, 3.0 specific gravity (in all) and 5.4 Km^2 areas. Hoshi-Sabrin ironstone 21samples show Fe_2O_3 40.28% - 73.63%, SiO_2 1.16% - 33.70%, P_2O_5 0.0% - 3.27%, TiO_2 0.0% - 0.8%, Al_2O_3 0.0% - 9.07%, CaO 1.96% - 15.14%, MgO 0.0% - 4.84%, S traces-0.1% and LOI 7.3% - 20.7%. Hoshi proved iron ore reserves are 49.53 mt based on an average 2 m thickness and 8.25 Km^2 area while Sabrin ironstone reserves are 1.62 mt based on over 0.27 Km^2 areas and 2 m thickness. Gorjat ironstone 24 samples show Fe_2O_3 40.93% - 70.8%, SiO_2 11.6% - 24.52%, P_2O_5 0.0% - 3.3%, TiO_2 0.0% - 0.64%, Al_2O_3 0.0% - 14.84%, CaO 0.0% - 16.2%, MgO 0.0% - 5.83%, S traces-0.14% and LOI 0.0% - 16.48%. Proved iron ore reserves of Gorjat area are 32.637 mt based on average 3 m thickness and 3.956 Km^2 area. It's indicated reserves are about

Table 1. Chemical analyses of Khad Kucha and Johan ironstone (Dilband-Johan iron) samples collected by M. Sadiq Malkani (present author) and Masud Tariq (Geologist) during field 1990-91 under the project of Geological mapping and mineral investigation. These samples were chemically analyzed by Mr. Allah Bakhsh, Chemist, supervised by Mr. Mushtaq Hussain, Chief Chemist, Chemistry Lab, Geological Survey of Pakistan, Quetta, conveyed via Chemical analysis Report No. Chem (91-92) 10 dated January 16, 1991.

Lab No.	Sample No.	Locality	Nature of beds	Fe_2O_3 %
1981 (8)	MS-36	North of Johan town and Southwestern part of Dilband Range (Kalat)	Ironstone bed	56.01
1981 (9)	MS-37	North of Johan town and Southwestern part of Dilband Range (Kalat)	Ironstone bed	69.66
1981 (9)	MS-37	North of Johan town and Southwestern part of Dilband Range (Kalat)	Ironstone bed	69.75
1981 (13)	MS-44	Khad Kucha Range, east of Tehsil offices of Khad Kucha (Kalat)	Ironstone small lenticular pocket	24.79

140 mt. Gorjat Nala ironstone 17samples show Fe_2O_3 40.05% - 58.64%, SiO_2 14.20% - 31.64%, P_2O_5 0.08% - 0.82%, TiO_2 0.01% - 0.40%, Al_2O 2.20% - 12.55%, CaO 3.36% - 18.57%, MgO 0.80% - 5.64%, S traces-1.16% and LOI 7.10% - 20.27%. Proved iron ore reserves of Gorjat Nala area are 39.375 mt based on average 3.5m thickness and 3.750 Km^2 area. Dilband-Shikarap ironstone 20 samples show Fe_2O_3 35.29%-54%-85%, SiO_2 9.60% - 25.54%, P_2O_5 0.0% - 2.76%, TiO_2 0.00% - 0.1%, Al_2O 1.18% - 14.56%, CaO 5.04% - 25.28%, MgO 0.08% - 4.83%, S traces-0.41% and LOI 8.51% - 16.84% [82] [83]. Proved iron ore reserves of Dilband-Shikarap area are 36 mt based on average 1 m thickness and 12 Km^2 areas. This ironstone is suitable for exploitation due to its large reserves, gentle dips, open pit mining, suitable elemental compositions and close to Mach and Kolpur railway station. The installation of gravity fall belt from the peak to the downward plain base station on the bank of Moro (Morov) river where truck can load and shift ironstones to Mach railway station. Another option is shifting ore from the site to Kolpur railway station by truck and then by railway. The recent investigation shows ironstone isolated lense-shaped extension in the north upto Murdar Ghar (Quetta), in the east up to Dirao area, in the west Koh Siah and Koh Maran ranges, and in the south up to Nur Gama Zahri area of Khuzdar district.

Terrestrial water resources of Indus Basin are too much and rainwater is going into the sea creating flood and loss in the agricultural lands and population, so smaller dams along with major dams are vital for Pakistan because its population is increasing rapidly. The construction of large dams can provide cheap electricity to the people of Pakistan. In short, the mineral, gem and coal deposits and terrestrial water resources of the area need further exploitation for the development of the areas, provinces and ultimately for Pakistan.

3.2. Stratigraphic Sequential Variations and Major Anticlinal Structures in Indus Basin of Pakistan

Indus super basin is divided into 3 basins Upper Indus basin (Kohat-Potwar-Kotli basin), middle Indus (Sulaiman basin) and lower Indus (Kirthar basin) and further subdivision (Figure 1). The uppermost part of Indus Basin sometimes called as uppermost Indus Basin or northernmost Indus Basin is represented by Khyber-Hazara-Neelam belt. The Neelam River host the oldest Precambrian Salkhala Formation (slate, phyllite, shale, dolomitic limestone, and graphite and other igneous rocks, maybe some gypsum), while Hazara region consists of coeval Hazara Formation and Khyber region represents coeval Attock slates, Dhakhner, Shekhai formation and Manki formations, etc. Further, these areas have rich local stratigraphy can be seen in [49] [50]. Here only sedimentary sequences are mentioned. This region is folded and rich faulted. The southern part is less metamorphosed while the northern part is strongly metamorphosed yielding valuable gemstones. The type localities of most of the geological formations of lower and middle Indus basins are figured in [26] and Balochistan Basin including Makran-Siahan Ranges (southern Balochistan basin), Pishin basin/Kaker Khorasan (northern Balochistan basin) and Balochistan arc/Chagai arc are figured in [52]. Most of the sections started from the core of anticlines and ended at the core of syncline and only a few were taken from the limbs and fixed portions. The thicknesses of the formations mentioned are purely tentative estimates.

3.2.1. Stratigraphic Sequential Variations and Major Anticlinal Structures in the Upper Indus Basin (Kohat-Potwar-Kotli Basin) of Pakistan

Recently the stratigraphy of the upper Indus basin was presented by [49] [50]. The northern part of the upper Indus show more marine and dolomitic carbonate strata (Figure 3) (Figure 4) while the southern part host dolomitic carbonate along with more arenaceous and evaporitic deposits (Figure 5). The northern part of this belt is represented by Muzaffarabad-Kotli to Nathiagali Abbottabad to Kala Chita to Samana Range to northern Parachinar. The Abbottabad-Nathiagali-Murree section (Figure 4) [15] represents the following lithostratigraphy. Precambrian Hazara Slates consist of mainly slates with some dolomitic limestone and some gypsum. It is correlated with Salkhala slates of Neelam (its type locality is after Salkhala village located on the southern bank of Neelam River) and Reshian valleys and Salt Range Fm in the southern base of Salt Range. Cambrian Abbottabad (dolomite, dolomitic limestone, quartzite/sandstone, with some shale and conglomerate) Formation and Jurassic Datta (sandstone/quartzite) and Samanasuk (limestone and dolomitic limestone with minor shale; dinosaurs trackways horizon is shown in Baroach Nala Malakhel section in Figure 4) Formation are present. Cretaceous Chichali (black to grey shale with glauconitic, chamositic/septechlorite, iron beds with other minerals; well exposed a few kilometers north of Thandiani) and Kawagarh (limestones) formations, and Latest Cretaceous to Earliest Paleocene Indus (laterite, bauxite and fire clay; pisolitic and oolitic nodule common; Cretaceous-Paleogene K-Pg boundary laterite) are present. Paleocene Hangu (coal, shale, sandstone, chamositic ironstone; Hangu Formation is coeval of Patala Formation; shale is common in the Tatta Pani, Kotli

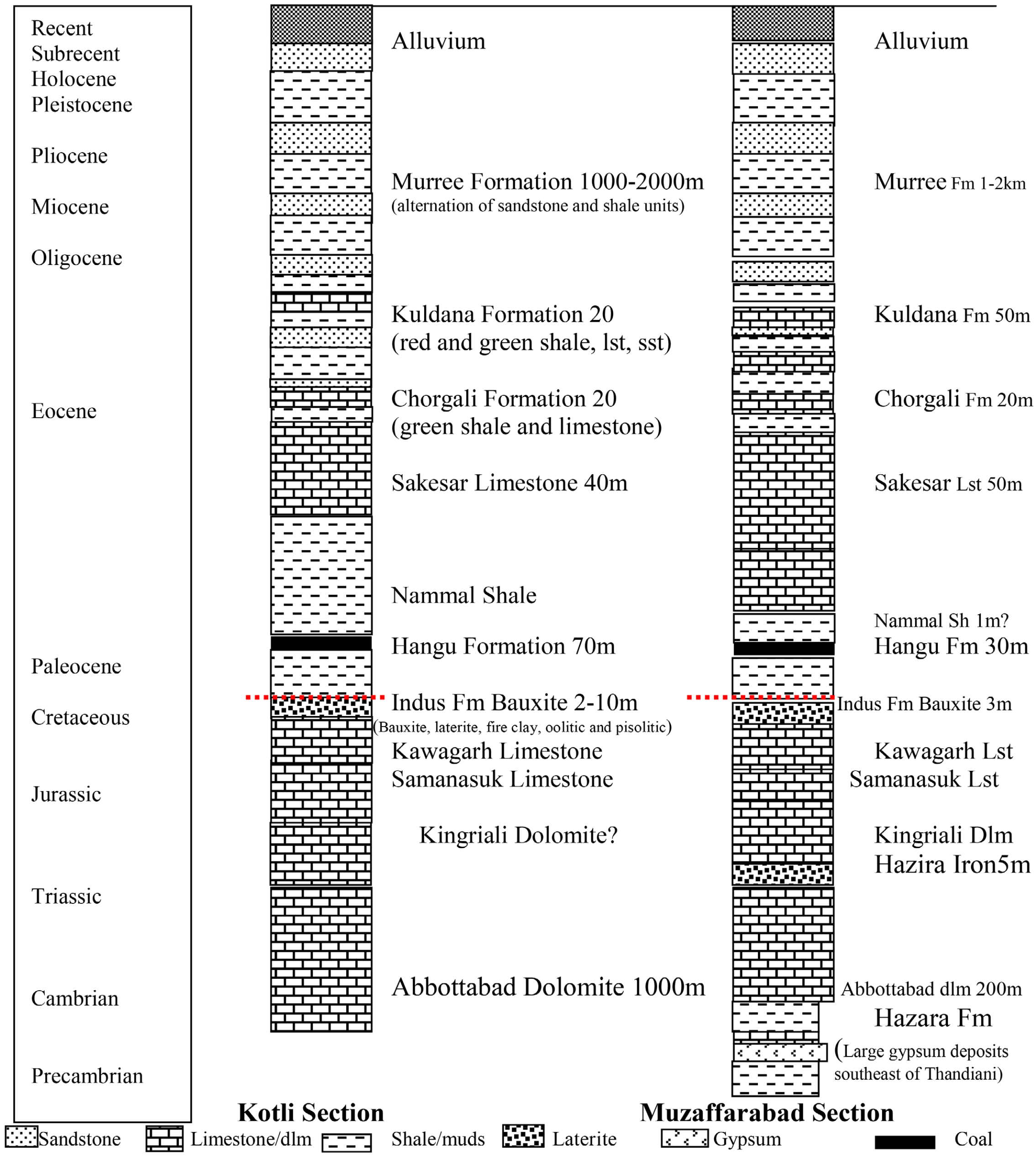

Figure 3. Stratigraphic Sequence exposed at Muzaffarabad (1) and Kotli (5) sections of Azad Kashmir (Pakistan). Salkhala Formation exposed only in Neelam valley from Nausehri to uppermost Neelam/northern Indus Suture. Note, the measurements are estimated and purely tentative for all sections. Not to scale. For location see Figure 1. Red dotted line shows infraPaleogene or infraTertiary boundary. Abbreviations; dlm for dolomite, lst for limestone, sh for shale, sst for sandstone, fm for formation, congl for conglomerate, cm for centimeter, m for meter, km for kilometer. Formation name followed by dominant lithology to understand and differentiate easily, if mixed then used Fm/Formation.

areas) and Lockhart (fine nodular limestone; nodule relatively less than Sakesar/Margala Hill Limestone) are present. Eocene Nammal (shale/muds, marl/limestone), Sakesar (coarse nodular/rubbly limestone; nodule relatively larger than Lockhart Limestone; coeval and also synonym of Margala Hill Limestone), Chorgali (shallow marine green shale and limestone) and Kuldana (alternating red and green shale, limestone and sandstone; transitional marine and continental) formations are present. Miocene-Pliocene Murree Formation (continental red muds, sandstones and some conglomerate); and Quaternary alluvium

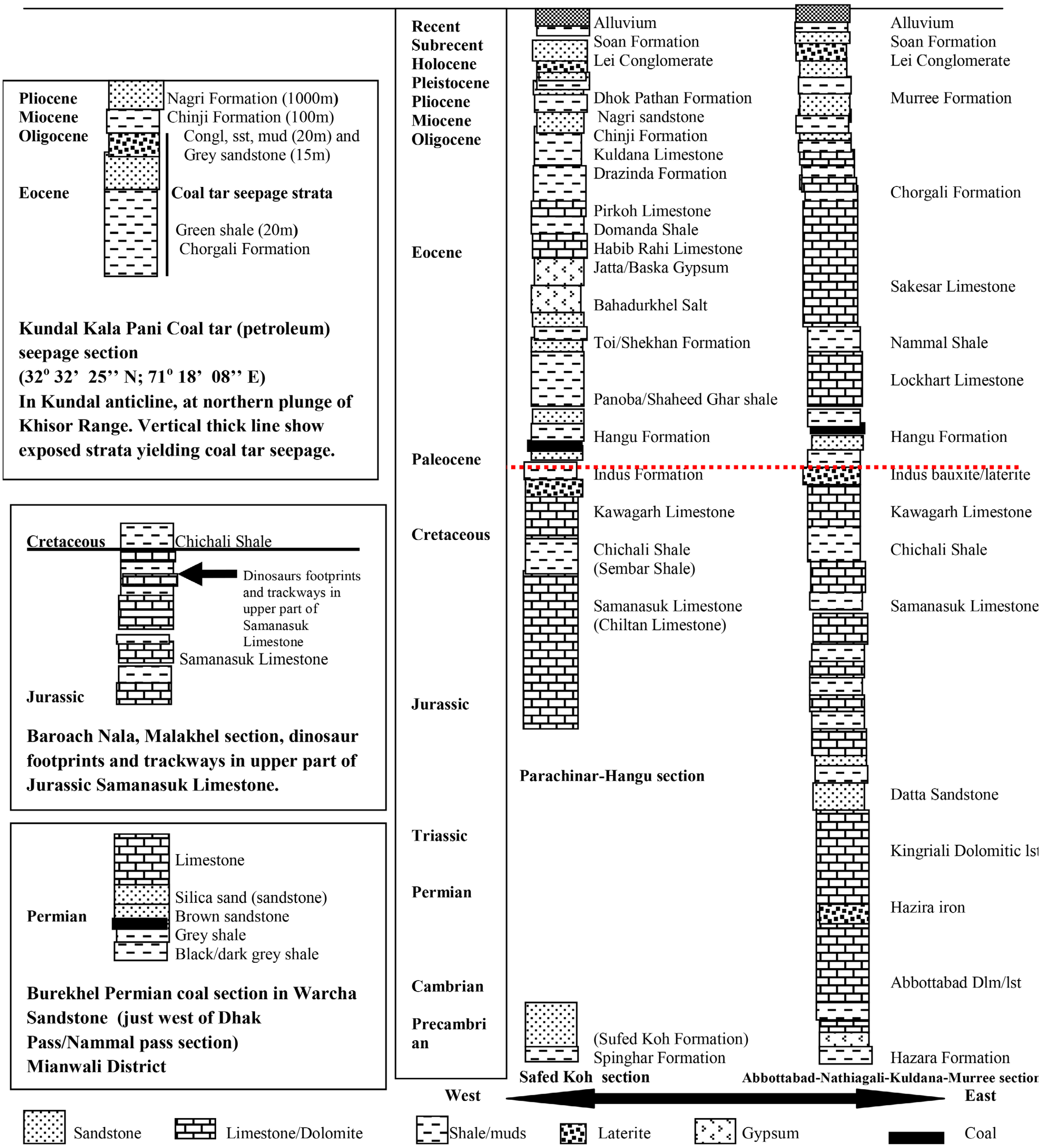

Figure 4. Stratigraphic Sequence exposed at Abbottabad-Nathiagali-Kuldana-Murree section (2), Safed Koh (3) (Sufed Koh) and Parachinar (4) sections. Further Kundal Coal tar (petroleum) seepage (11), Burekhel Permian coal (8) and Baroach Nala of Malakhel section (10) are presented. Not to scale. For location see Figure 1. Hazira iron is well exposed few kilometers north of Thandiani on road to southwestern Lowari hill of Muzaffarabad. Red dotted line shows disconformable Cretaceous-Paleogene (K-Pg) boundary.

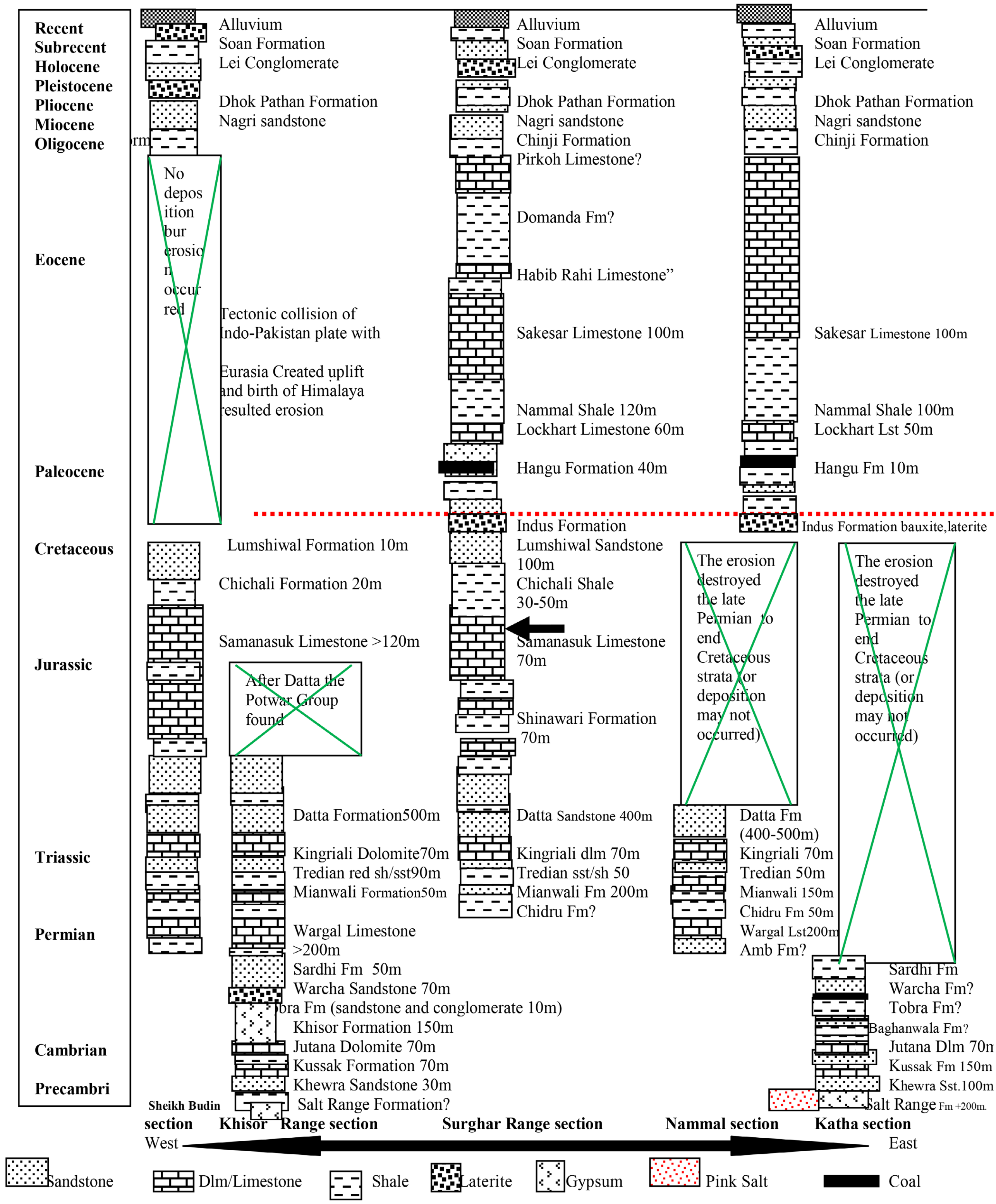

Figure 5. Stratigraphic Sequence exposed at Katha (6) and Nammal (7) sections (Salt Range), Surghar Range (9), Khisor Range (12) and Sheikh Budin hill (13) sections of Upper Indus Basin. Not to the scale. For location see Figure 1. Red dotted line show erosional/disconformable contacts at Surghar section while at Katha and Nammal sections it is infraPaleogene boundary. Thick arrow pointing in the upper part of Samanasuk limestone shows the horizon of footprints and trackways of dinosaurs.

including conglomerate, sandstone and mudstone are present. Structurally the road section shows intensive faulting especially thrusts, overturning of strata and some foldings. The major two thrusts are observed in the Abbottabad-Nathiagali section where the Precambrian Hazara Formation is thrusted on the Late Cretaceous Kawagarh and Early Eocene Chorgali Formations respectively. From Nathiagali to Kuldana many thrusts/imbricate faultings are observed in Mesozoic and Cenozoic strata (relatively younger strata). The vertebrate paleontological significance of this area is the findings of the Early Eocene walking whale (mammalian evolution from land to sea) and other mammalian fauna from Kuldana Formation. The general trends of thrust lines are northeast and join with the Jhelum thrust fault in the northeast and also become almost east-west on joining with Kala Chita Range in the southwest. In the Muzaffarabad section (**Figure 3**) the stratigraphy is almost the same, while no phosphatic localities are discovered from here so far. Here the structure is a Muzaffarabad thrusted anticline. This anticline generally trends northwest to southeast with a doubly plunging nature. The northeastern limb is normal while the southwestern limb is overturned. This anticline is located in the northwestern, northern and northeastern vicinity of Muzaffarabad city. The Kotli section (**Figure 3**) also represents mostly the same stratigraphy, the only difference is that the thick infratertiary laterite (Indus Formation) and also more thick dolomitic limestone continue from the infratertiary boundary to Cambrian. Apparently, this dolomitic limestone is commonly called Abbottabad dolomitic limestone because no boundaries are found. But due to its thickness than normal, it is possible that the other sequence above the Cambrian may exist here. It needs a detail study to clear whether it is the erosional impact due to tectonic or dolomitic limestone of all or some infra tertiary formations which are present in Nathiagali and surrounding areas. Intense folding and faulting are observed in the Kotli thrusted anticlinal area produced by the convergence of the Indo-Pakistan plate with the Asian plate. Many strike-slip, thrust and imbricate faults are found. The Kotli area consists of many alternations of synclines and anticlines generally trending NNW-SSE. Kotli section (**Figure 3**) was taken from Tatta Pani anticlinorium. Tatta Pani Anticlinorium represents moderate to high dips, and Cambrian Abbottabad Formation is the core formation. Terminal Cretaceous Indus, Early Paleocene Hangu (Patala), Eocene Nammal, Sakesar, Chorgali and Kuldana and Miocene-Pliocene Murree formations are found on the both limbs. A major thrust fault (after the Jhelum fault) runs from Tatta Pani to Muzaffarabad deduced from previous earthquake intensity, Tatta Pani hot spring and other many features.

The western extension of this northern portion extends upto Koh Safed and Parachinar area. Koh Safed mountain (**Figure 4**) shows mostly Spinghar Formation (Safed Koh Formation) consisting of possibly Indo-Pakistan shield materials. The Parachinar section (**Figure 4**) shows stratigraphy representing interfingering of Sulaiman basin and Kohat-Potwar-Kotli basins. The Jurassic Samanasuk limestone (Chiltan Limestone), Cretaceous Chichali shale (Sembar Shale) and Kawagarh Limestone, Early Paleocene Indus Formation laterite and middle to late Paleocene Hangu Formation, Early Eocene Panoba shale (Shaheed Ghat shale), Chashmai and Gurgari Formations (Toi and Kingri Formations), Sheikhan Formation, Bahadurkhel Salt, Jatta Gypsum, Habib Rahi, Domanda, Pirkoh and Drazinda formations, Kuldana Formations, Chinji, Nagri, Dhok Pathan Formations, Lei conglomerate and Soan Formation.

The Salt Range (Katha and Nammal sections; Figure 5), Surghar Range (Figure 5), Khisor Range (Figure 5) and Sheikh Budin hill (Figure 5) sections have mostly the same stratigraphy but some variations (Figure 5). The Baghanwala Formation of Salt Range is replaced by Khisor gypsum in Khisor Range. Further the Hangu Formation of Surghar Range and Nammal sections continue to the eastern Salt Range and Kotli area producing coal, while fine clastic materials and shale increase eastward up to Kotli revealing sand source of Hangu Formation is from south or west and not from east. Its sandstone concentration is being reduced as moving eastward (from Hangu to Katha/Abbottabad and Muzaffarabad/Kotli). But in Salt Range it is commonly called Patala Formation but in actual it is Hangu Formation, however, age may extend up to earliest Eocene. There is no any section that shows the occurrences of both formations in one place. So Hangu name may be used only to avoid any ambiguity in working of Abbottabad coal, Muzaffarabad Coal and also Kotli coal. All these coal belongs to Hangu Formation. Finding of extension of Hangu coal in Tarah area [80] of Khyber agency is encouraging. The stratigraphy of southern part of upper Indus Basin is presented as follows. The oldest Formation is Precambrian Salt Range (evaporitic and terrestrial; pink salt, red shale, marl, gypsum, sandstone). Cambrian Khewra Group represented by Khewra (mainly purple sandstone), Kussak (glauconitic and micaceous sandstone and siltstone interbedded with dolomite), Jutana (mainly dolomite and shale) and Baghanwala (red shale alternated with flaggy sandstone exposed in Salt Range), Khisor (thick gypsum in the base and shale in the upper part exposed in Khisor Range) Formations. Early Permian Nilawahan Group represented by Tobra (freshwater facies of siltstone and shale with pollen and spore flora, and a complex tillites facies of diamictite, sandstone and boulder beds increase in western Salt range and Khisor range), Warcha (speckled sandstone with some shale and coal; Burekhel Permian coal Figure 4); Dandot is local and lateral variation of widely used Warcha, so Dandot is its synonym) and Sardhi (greenish-grey clay with some sandstone, siltstone and limestone) Formations. Middle to Late Permian Zaluch Group represented by Amb (sandstone, limestone and shale), Wargal (mainly limestone and dolomite) and Chidru (shale, quartzose sandstone with minor limestone) Formations, and Triassic Musakhel Group represented by Mianwali (marl, limestone, sandstone, siltstone and dolomite), Tredian (sandstone of terrestrial environments) and Kingriali (dolomite, limestone, dolomitic limestone, marl, sandstone and shale) Formations. Jurassic Surghar Group is represented by Datta (terrestrial deposits like sandstone, shale, ferruginous glass sand and fire clay in the lower part), Shinawari (shale, marl and limestone) and Samanasuk (mainly limestone with minor shale; dinosaur trackways horizon in Surghar Range section, **Figure 4** & **Figure 5**) Formations. Chichali Group represented by Chichali (dark greenish grey glauconitic sandstone and glauconitic shale), Lumshiwal (cross-bedded sandstone and shale of continental origin; coeval to Pab Sandstone of middle and lower Indus basins), Kawagarh (marl and limestone and shale) and Indus (lateritic and bauxitic beds along with pisolitic beds) Formations. The latest Cretaceous or Earliest Tertiary Indus Formation type locality [49] [50] is Narali area (eastern limb) of Tatta Pani Anticlinorium (43K/2), District Kotli, Azad Kashmir (Pakistan). Paleocene Hangu Group is represented by Hangu (sandstone with grey shale and coal) and Lockhart (fine rubbly limestone relative to Sakesar limestone/Margala Hill limestone Formations). Nammal Group is represented by Nammal (shale, marl and limestone) and Sakesar (dominant limestone with subordinate marl; synonym with Margala Hill Limestone) Formations. Nammal and Kuldana Groups are exposed in Potwar-Nathiagali-Muzaffarabad regions while Panoba and Kahan Groups are well exposed in Kohat Region of upper Indus Basin. Panoba and Nammal Groups are correlated with the Chamalang Group of Sulaiman and western Kirthar fold belt and Sohnari Formation of the eastern Kirthar foldbelt. Kuldana Group is correlated with Kahan Group of Kohat sub-basin and Middle Indus basin. Panoba Group represented by Panoba (greenish grey shale with occasional beds of sandstone and limestone), Chashmai (sandstone and green shale; correlated and coeval with Toi Formation of middle and lower Indus basins), Gurguri (sandstone and brown shale; correlated and coeval with Toi Formation of middle and lower Indus basins), Sheikhan (limestone, shale and sandstone; correlated with Drug marl and shale of middle Indus basin), Bahadurkhel Salt (white salt and the upper salt is grey to black) and Jatta Gypsum (gypsum and some clay partings; correlated and coeval with Baska Gypsum). Kahan Group represented by Habib Rahi (mainly light brown limestone with subordinate marl and shale), Domanda (mainly shale with some marl), Pirkoh (mainly white limestone with subordinate marl and shale) and Drazinda (mainly shale with subordinate marl) Formations. Middle to Late Eocene Kuldana Group is represented by Chorgali (green shale and limestone; Kundal coal tar seep **Figure 4**) and Kuldana (red shale, sandstone and bleached dolomite; show transition toward Murree Formation) Formations. Potwar Group represented by Chinji (red shale and grey to brownish grey sandstone), Nagri (greenish grey sandstone and chocolate brown shale, and conglomerate), Dhok Pathan (monotonous cyclic alternations of grey, greenish grey and brown sandstone, and chocolate color and rusty orange and grey to greenish grey shale, and conglomerate lenses and beds) Formations. Soan Group is represented by Lei Conglomerate (coarse clastics, conglomerate with minor shale and sandstone) and Soan (fine clastics, sandstone, mud and conglomerate) Formations. Subrecent and Recent deposits cover most of the valleys and plain areas. Sheikh Budin hill section (**Figure 5**) hosts the exposed Tredian, Kingriali, Datta, Shinawari, Samanasuk, Chichali and

Lumshiwal Formations along with the Potwar and Soan Group fluvial deposits. Sheik Budin Hill and Khisor Range (form arc shape) and represents a major thrust fault on the southern and eastern end of Range. This thrust joins with Surghar thrust which turns eastward from the northern end of Surghar (west of Kalabagh) and continues up to Nammal, Warcha, Khewra and south of Mirpur and Bhimbar.

3.2.2. Stratigraphic Sequential Variations and Major Anticlinal Structures in the Middle Indus Basin (Sulaiman Basin) of Pakistan

The Sulaiman Basin (Middle Indus Basin) consists of about 10 km thick sedimentary sequence (**Figure 6**) (**Figure 7**) [49] [50] [21]-[27]. The oldest Sulaiman Group (Permian-Jurassic) represents Permian to Triassic Wulgai (shale with subordinate limestone; Wulgai section (**Figure 7**), Jurassic Loralai (limestone bed alternating with shale) and Chiltan (mainly limestone) Formations. The Early Cretaceous Parh Group is represented by Sembar (mainly shale with minor marl), Mekhtar (quartzose sandstone; commonly called lower Goru), Goru (shale and marl), and Parh (limestone) Formations. The Late Cretaceous Fort Munro Group is represented by Mughal Kot (Mughalkot, manly shale with subordinate sandstone and rare limestone), Fort Munro (locally developed limestone), Pab (sandstone with subordinate shale) and Vitakri (red muds and greyish white sandstone) Formations. The Mughalkot in Rakhi Gaj section consists of almost mudstone/marl and in Tor Thana (between Mekhtar and Loralai) it consists of large Parh type limestone boulders. The Fort Munro limestone is only found in the Rakhi Gaj (and nearby northern and southern extremity) and Morov (Maximum thick at Dilband-Johan) to Sor Range to Hana Lake (pinched here a few meters) sections. In other places, it is not well recognized. The Sor Member ([26], page 529) of Pab Formation is widely exposed from Qila Saifullah to Musafar Pur (Sor Muzghai) (**Figure 8**) to north of Murgha Kibzai to Manikhawa Shirani to Waziristan [26] [52]. The sandstone of Sor Member hosts the footprints and partial trackways of dinosaurs and pterosaurs (**Figure 8**). The Kali Member ([27], page 903-904; [84] page 5) of Pab Formation is exposed in Tor Thana area (**Figure 8**), western Sulaiman and also western Kirthar (**Figure 9**) Foldbelts ([27], pages 903-904) where black desert varnish is common and further sandstone matrix is more muddy. The Dhaola Member ([27], pages 903-904; [84], page 5) of Pab Sandstone is found in eastern Sulaiman (**Figure 8**) and eastern Kirthar (**Figure 9**) Foldbelts ([27], pages 903-904). The sandstone of Dhaola Member hosts the sauropod possibly titanosaurian *Dgkhansauroperus* footprint (**Figure 8**). All these three members of Pab Sandstones ([27], pages 903-904) are laterally/horizontally variable (**Figure 8**) and extensions. The Vitakri Formation ([27], pages 904, 905) which is deposited just below the Cretaceous-Paleogene boundary (**Figure 7**) yielded the last dinosaurs, mesoeucrocodiles and pterosaurs, snakes, birds and mammals (see above and below). In the Vitakri and Bara Khadro areas and its vicinity, it is maximum thick, host vertebrate and invertebrate fossils also have conformable lower and upper contacts. Its upper contact shows the Cretaceous-Paleogene boundary (**Figure 7**). The Paleocene

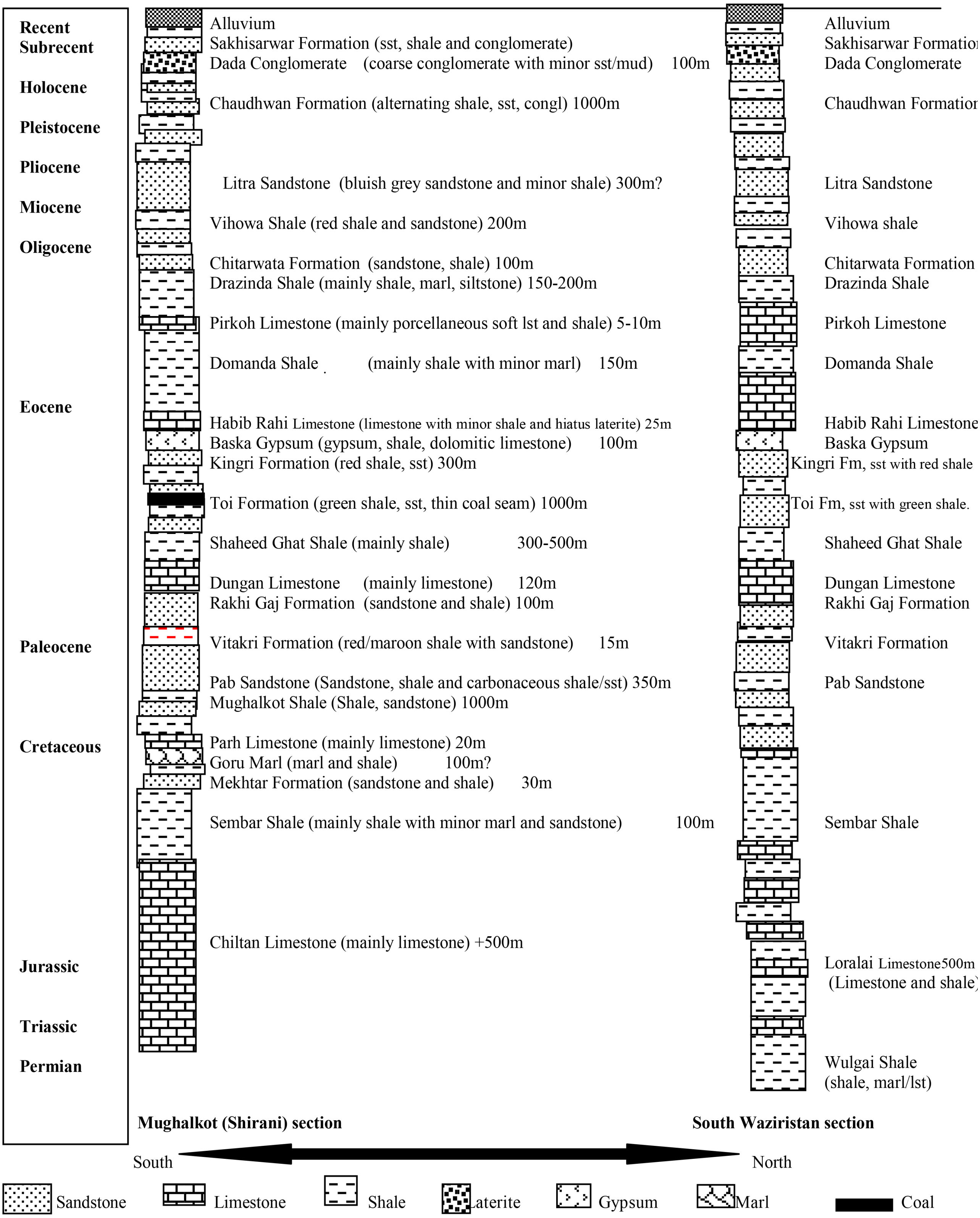

Figure 6. Stratigraphic Sequence exposed at South Waziristan (western Indus Suture-Wana to Tank plain) (14) and Mughalkot (Northern Toi Nala of Shirani, D.I.Khan) (15) sections. (Mughalkot section started at core of main Takht Sulaiman thrusted anticline just east of Dhana Sar and continues to Mughalkot to Domanda to Chaudhwan). Not to the scale. For location see Figure 1.

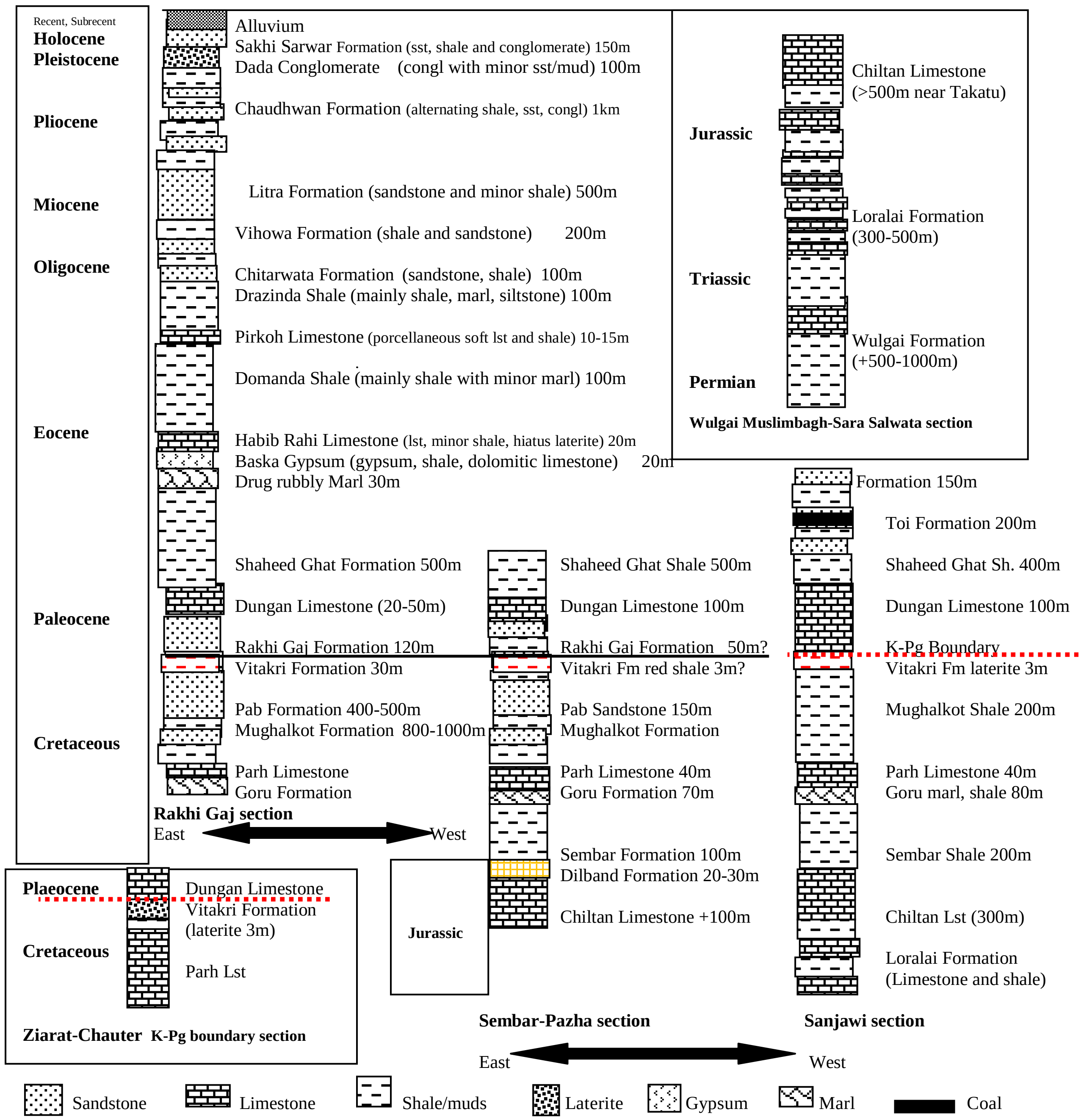

Figure 7. Stratigraphic Sequence exposed at Rakhi Gaj (Dera Ghazi Khan) (23), Des-Mazar Drik-Sembar-Pazha (Kohlu District) (24), Sanjawi (Ziarat and Loralai) (21), Ziarat Chauter (Ziarat District) (22) and Wulgai Muslimbagh (Qila Saifullah) (18) sections. Not to the scale. For location see Fig. 1. The red dotted line show disconformable contact while black line show conformable contact.

Sangiali Group represents Sangiali (basalticlastic shale and sandstone with *Pakiwheel vitakri* [64] nautiloids and light brown weathered limestone; local development), Rakhi Gaj (Girdu member, volcaniclastic and hematitic sandstone; Bawata member, alternation of volcaniclastic shale and sandstone), and Dungan (limestone and shale) formations. The Dungan Formation has significant variations from massive limestone (at Harrand, Zinda Pir, Mughalkot and western

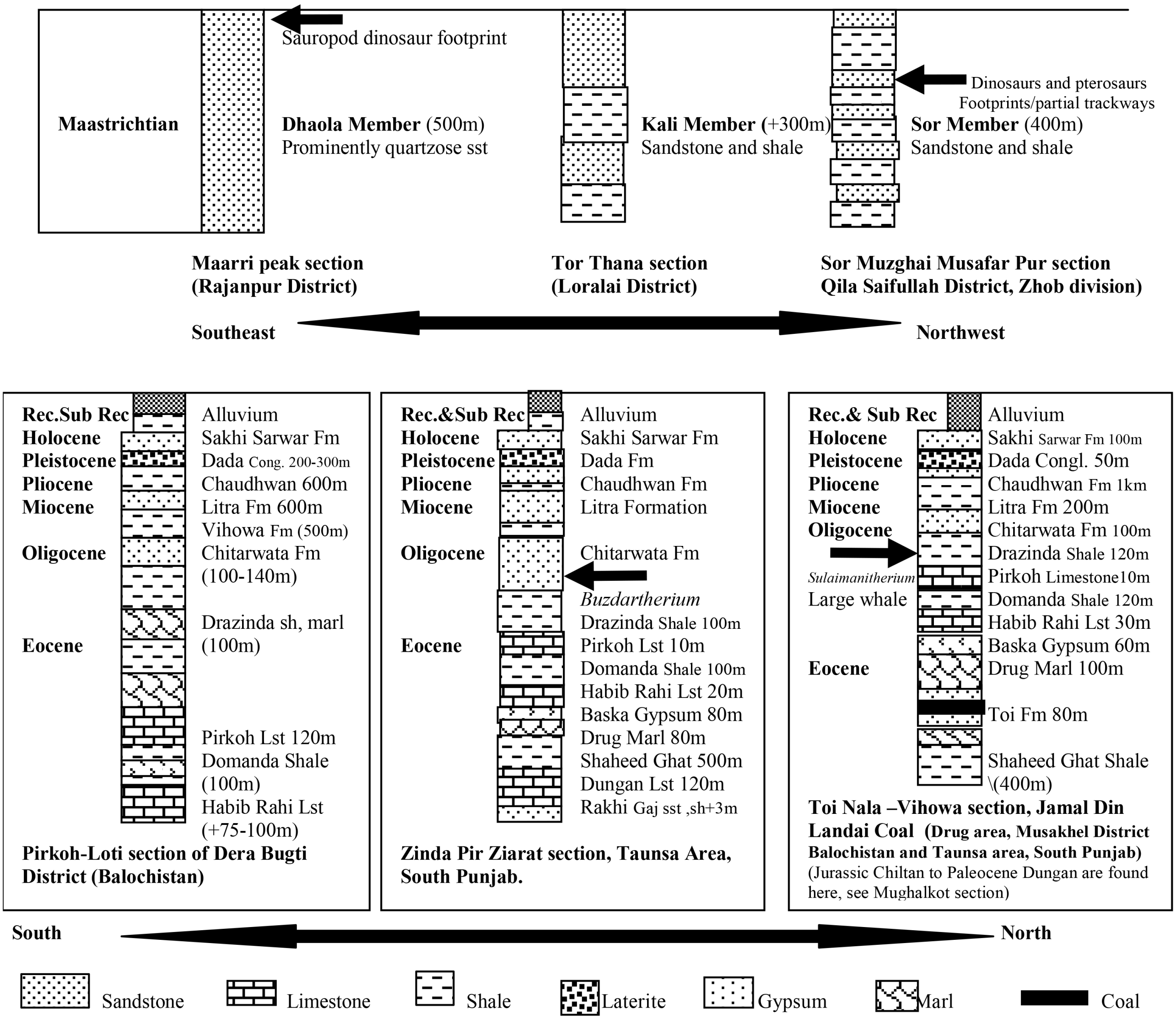

Figure 8. Stratigraphic Sequence exposed at southern Toi Nala section started from core of anticline just few kilometer east of Toi Sar Thana to Chitarwata to Vihowa/Litra (17), Zinda Pir Ziarat (19), Pirkoh-Loti (26) sections. Further horizontally variable Dhaola Member at Maarri peak (25), Kali Member at Tor Thana (20) and Sor Member at Musafar Pur (16) sections of Maastrichtian Pab Sandstone are also presented. The Sor Member which wholly represents Pab Sandstone exposed about 20km east of Qila Saifullah town continues to Sor Muzghai Musafar Pur to Manikhawa Shirani to Waziristan. The Kali Member which wholly represents Pab Sandstone exposed at and surroundings of Tor Thana (Loralai District) and Sembar-Pazha areas of Kohlu District. The Dhaola Member wholly represents Pab Sandstone exposed at Maarri peak, Daragal and Chitri (Rajanpur District), Fort Munro, Hikbai and Mubarki (Dera Ghazi Khan),, Kharar, Pir Gahno, Hinglun and Luni sections (Taunsa areas), Andari, Dhaola, Mazara, Dada and Rarkhan (Barkhan District), Musa Khel Bazar, Tangi Sar Drug, Savi Ragha and Zamri areas (Musakhel District) and Mughalkot and Drazinda Shirani (D.I.Khan District). Not to the scale. For location see Figure 1.

Indus suture and its surroundings) to a few thin beds of limestone (at Rakhi Gaj and Mekhtar Spin Ghar section). The Early Eocene.

Chamalang Group represents Shaheed Ghat (shale), Toi (sandstone, shale, rubbly limestone and coal), Kingri (red shale/mud, grey and white sandstone), Drug (rubbly limestone, marl and shale), and Baska (gypsum beds and shale) formations and Early/Middle to Late Eocene Kahan group represents Habib

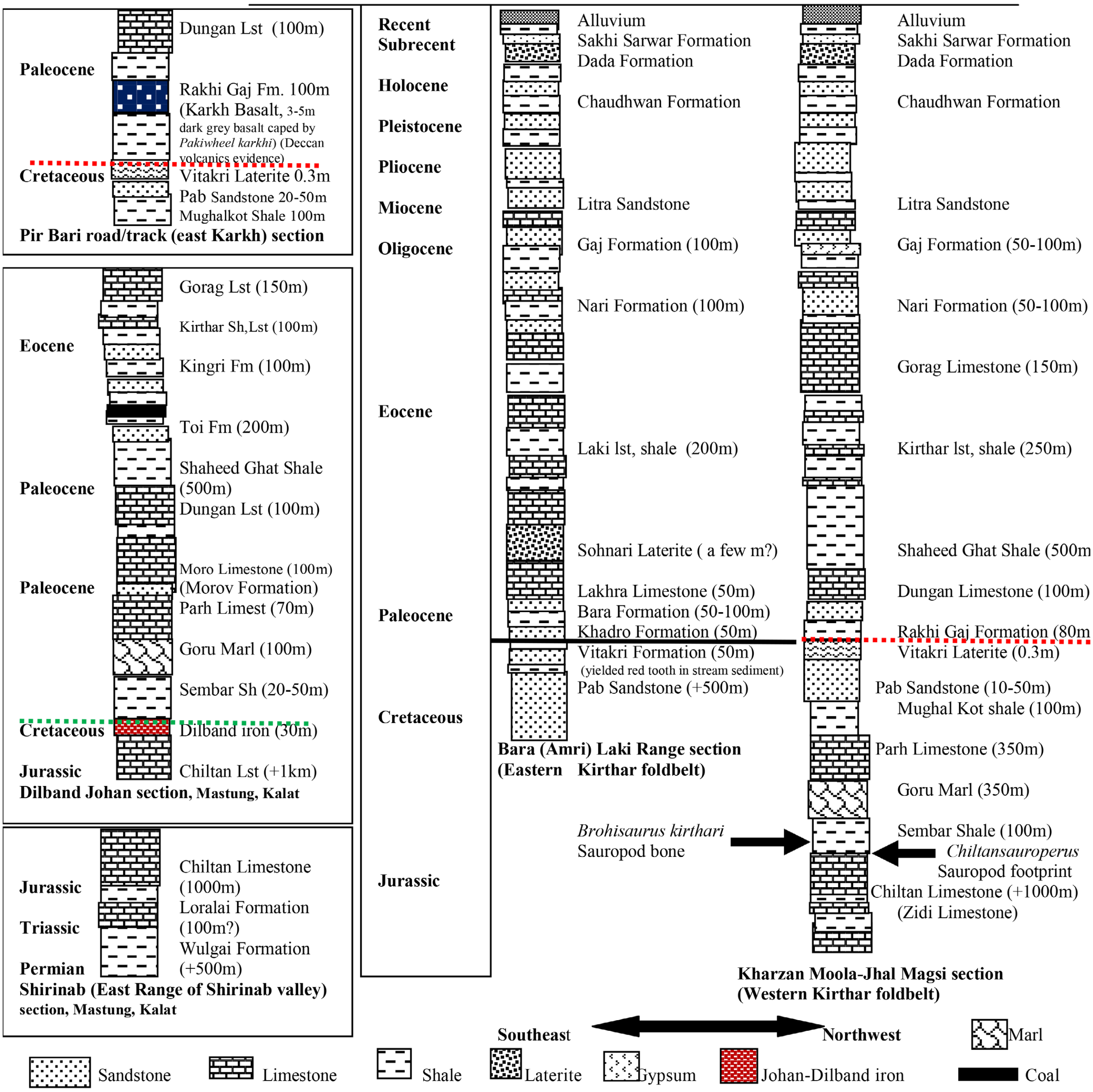

Figure 9. Stratigraphic Sequential variation between eastern Kirthar foldbelt (Bara Laki section; 31) and western Kirthar (Kharzan Moola-Jhal Magsi section 29) foldbelts. Further Shirinab Valley (Mastung Kalat) (27), Dilband-Johan (Mastung, Kalat) (28), and Pir Bari road eastern kund of Karkh (Khuzdar) (30) sections are presented, Pakistan. Not to the scale. For location see Figure 1. The red dotted line show Cretaceous-Paleogene (K-Pg) boundary with disconformable contact, while the thick black line just above the Vitakri Formation shows the Cretaceous-Paleogene conformable boundary. The green dotted line shows Jurassic-Cretaceous boundary, a disconformable contact. Plus + symbol before thickness indicates the base is not exposed or the remaining portion is not exposed.

Rahi (limestone, marl and shale), Domanda (shale with one bed of gypsum), Pir Koh (limestone, marl and shale) and Drazinda (shale with subordinate marl) formations. The Toi and Kingri Formations are found in central, western and northern Sulaiman fold belt and not found in southeastern part of Sulaiman fold belt like Taunsa (Zinda Pir, Pir Gahno and Manjhail areas; Figure 8) to D.G.Khan (Rakhi Gaj; Figure 7) to Rajanpur to Dera Bugti areas. Even these are not found in the southern and eastern parts of Kohlu District like Jhabar, Pinghora, Janthali, Kahan, Tadri, Triman, Makhmar and Mawand areas and also in southern and eastern part of Barkhan District like Lakha Kach Rakhni, Kharcha, Vitakri and Mazara-Dhaola-Andari Range. However, the northern and northwestern part of Kohlu and Barkhan Districts has coal hosting these formations. The Kahan Group yielded the largest marine mammal whales. The Oligocene-Pliocene Vihowa Group represents Chitarwata (grey ferruginous sandstone, conglomerate and mud; host of *Buzdartherium* large rhino and *Asifcroco* eucrocodile shown at Zinda Pir Taunsa section, Figure 8), Vihowa (red ferruginous shale/mud, sandstone and conglomerate), Litra (greenish grey sandstone with subordinate conglomerate and mud), and Chaudhwan (mud, conglomerate and sandstone) formations, and Pleistocene-Holocene Sakhi Sarwar group represents Dada (well-developed conglomerate with subordinate mud and sandstone) and Sakhi Sarwar Formation (poorly developed conglomerate with subordinate mud and sandstone, while in centre of valleys the mud is dominant) concealed at places especially in the valleys and plain areas by the Subrecent and Recent fluvial, eolian and colluvial deposits. The Oligocene terrestrial Chitarwata Formation is only found in the middle Indus basin which yielded the largest land mammals. Foldings (repeated anticlines and synclines) are common in the middle Indus Basin. Anticlinal core represents the oldest rocks as in Shinghar-Takht Sulaiman and Sembar Mazar Drik host the oldest Chiltan Formation (Figure 7). The Gadebar and surroundings anticlines (Loralai region) host the Loralai Formation in the core. The anticlines in the western Indus Suture and eastern vicinity host the Wulgai and Loralai Formations in the core. In Tangi Sar, Andar Pur, Hinglun, Shadiani Fort Munro, Hanki, Tadri Khatan, Triman Khatan, Gamboli anticlines the Early Cretaceous Parh is exposed. In the Pirkoh anticline, the core formation is Habib Rahi exposed in southern limb of Pirkoh anticline. This core formation is becoming younger as shifting anticlines southward and eastward. The South Waziristan section (Figure 6) show Permo-Jurassic strata is almost same or slightly less than southern Sulaiman basin, while Cretaceous and Paleogene strata are pinched and reduced as comparison with Mughalkot Shirani section (Figure 6). The variation from Rakhi Gaj section (Figure 7) to Sanjawi section (Figure 7) to Des-Mazar Drik-Pazha section (Figure 7) to further westward to Ziarat section (Figure 7) and Wulgai section (Figure 7) are presented. Further from north to southward variation can be seen from Toi Nala section (Figure 8) to Zinda Pir section (Figure 8) and Pirkoh-Loti section (Figure 8).

3.2.3. Stratigraphic Sequential Variations and Major Anticlinal Structures in the Lower Indus Basin (Kirthar Basin) of Pakistan

The stratigraphic sequential variations are shown in eastern Kirthar (Sindh

Province) and western (Balochistan Province) Kirthar fold belts (**Figure 9**) [35] [36] [49] [50].

1) Stratigraphic sequential variations and major anticlinal structures in the lower Indus Basin (western Kirthar Basin; Balochistan Province) of Pakistan.

The western Kirthar foldbelt (western Lower Indus Basin; Balochistan Province) (**Figure 9**) [35] [36] [49] [50] consists of Permo-Jurassic Sulaiman Group represented by Permo-Triassic Wulgai Formation (shale and minor limestone and marl; shown in Shirinab section (**Figure 9**). Jurassic Anjira Formation (coeval to Loralai Formation; alternations of limestone and shale) and Chiltan Limestone (Zidi Limestone). The upper limestone bed of Jurassic Chiltan/Zidi Limestone hosts the sauropod *Chiltansauroperus* footprint (**Figure 9**). The Early Cretaceous Parh Group is represented by Sembar (mainly shale with minor marl; its lower part hosts *Brohisaurus kirthari*, **Figure 9**), Goru (dominantly marl/marly limestone with subordinate shale), and Parh (mainly porcellaneous white limestone) Formations. The Late Cretaceous Fort Munro Group is represented by Mughal Kot (Mughalkot, manly shale with subordinate sandstone and rare limestone), Pab (sandstone with minor shale) and Vitakri (laterite rich in bivalves *Pakiring kharzani* shells) Formations. The Fort Munro limestone is only found in Morov (Maximum thick at Dilband-Johan section; **Figure 9**) to Sor Range to Hana Lake (pinched here a few meters) and in the Rakhi Gaj Nala (about 100 m thick) and its nearby northern and southern vicinity. In other places it is not found, only a few limestone beds in upper Mughalkot shales are found in Karkh and Kharzan areas of Khuzdar District. The Pab is exposed only a few meters to 50 m thick in the Karkh area and diminishing toward north (Kharzan) and increasing toward south (Pab Range) and southeast (Bara Laki Range). Further Pab (Kali Member; more muddy sandstone with black desert weathering) exposed in Zidi area in the south of Khuzdar and extends southward to Wad and to Pab Range. Its thickness is increasing southward to Pab Range. Its thickness is maximum at its type locality Pab Range and in the Bara Khadro section of Laki Range. Kali Member [27] is exposed in the western Kirthar foldbelt while Dhaola Member (white quartzose sandstone) [27] is exposed in Eastern Kirthar foldbelt and eastern Sulaiman foldbelt. Its Sor Member is widely exposed from Qila Saifullah to Musafar Pur (Sor Muzghai) to north of Murgha Kibzai to Manikhawa Shirani to Waziristan [26]. These members are laterally variable. The Vitakri Formation which is deposited just below the Cretaceous-Paleogene boundary represented by a thin lateritic bed which host the *Pakiring Kharzani*. In the Vitakri and Bara Khadro areas and its vicinity, it is maximum thick, host vertebrate and invertebrate fossils also have conformable lower and upper contacts. Its upper contact shows the Cretaceous-Paleogene boundary (**Figure 9**). The Early Cretaceous shows mostly the same lithological units as Sulaiman basin during Mesozoic and Quaternary but vary in Tertiary strata.

Paleocene Sangiali Group represented by Rakhi Gaj (shale, basaltic beds capped by nautiloid *Pakiwheel karkhi* **Figure 9**, sandstone, negligible limestone) and Dungan (mainly limestone with minor shale) Formations. Early Eocene Chamalang Group represented by Shaheed Ghat (shale with minor marl), Toi (sandstone, shale, rubbly limestone and coal) and Kingri (red shale/mud, grey and white sandstone) Formations. The Toi and Kingri Formations are only exposed in northern part of western Kirthar fold belt in the Johan and Dilband (Mastung, Kalat) and surroundings. In the southern part of western Kirthar the only Shaheed Ghat shale is developed and exposed in Kharzan, Karkh and further southward. The middle to Late Eocene Kirthar Group represents Kirthar (limestone, marl and shale) and Gorag (resistant and peak-forming limestone with negligible shale and marl) Formations. The Oligocene Gaj Group represents Nari (sandstone, ironstone, shale, limestone) and Gaj (dominantly shale with rare sandstone, limestone and gypsum) Formations and Miocene-Pliocene Manchar Group represented by Litra (dominant sandstone with subordinate shale and negligible conglomerate) and Chaudhwan (dominant shale with subordinate sandstone and minor conglomerate) Formations which are mainly exposed on the eastern foot of Kirthar Range, while concealed in the plain areas by the Subrecent and Recent fluvial, eolian and colluvial deposits (**Figure 9**). The variation from Kharzan-Moola to Jhal Magsi section (**Figure 9**) (western Kirthar foldbelt to Bara Laki section (**Figure 9**) Karkh section of Khuzdar district show basaltic flows derived from Deccan volcanics at and close to K-Pg boundary (**Figure 9**) will help to find the age of host and surrounding strata matching with well dated Deccan volcanics.

2) Stratigraphic sequential variations and major anticlinal structures in eastern foldbelt of lower Indus Basin (eastern Kirthar fold belt; Sindh Province) of Pakistan.

The eastern Kirthar fold belt (eastern Lower Indus; Sindh Province) (**Figure 9**) [35] [36] [49] [50] consists of exposed Fort Munro Group represented by Mughalkot (mainly shale with negligible limestone) and Pab (white Sandstone; its Dhaola Member) and Vitakri Formation (red terrestrial sandstone with subordinate shale) exposed in the core of Laki (Lakhi) anticline and also west of Gorag (commonly called Gorakh a pleasant tourism locality) in Pab Range anticlinorium. The Vitakri Formation is about 50 m thick at Bara Khadro section of Laki Range which is pinching into a thin rusty brown laterite (few centimeters to about estimated 1 meter). This rusty laterite is full of *Pakiring kharzani* [64] a unique type of bivalves found in Kharzan section (just 3 - 4 km north of Kharzan town). The Bara Khadro stream sand (collected at Tangi at base of Laki Group) yielded red silicified tooth of fish or mammals [38] [51] may be derived from Vitakri Formation due to its red colour. Pab has 3 members namely Dhaola, Kali and Sor Members [27] which are laterally variable. Dhaola Member (white quartzose sandstone) is exposed in Eastern Kirthar foldbelt and eastern Sulaiman foldbelt. Kali Member is exposed in the western Kirthar fold belt and central Sulaiman fold belt. Its Sor Member is widely exposed from Qila Saifullah to Musafar Pur (Sor Muzghai) to north of Murgha Kibzai to Manikhawa Shirani to Waziristan [27]. The Paleocene Ranikot Group represented by Khadro (sandstone, shale, limestone and Deccan volcanics), Bara (sandstone and shale with coal) and Lakhra (limestones and shale) Formations. The Early Eocene Sohnari (lateritic clay and shale, yellow arenaceous limestone pockets, ochre and lignite seams) and middle Eocene Laki (shale, limestone, sandstone, lateritic clay and coal) are found. The Sohnari Formation is widely exposed in the Meting Jhimpir area (southwest of Hyderabad). The Sohnari represents the correlation with its coeval Chamalang Group in the northern Kirthar fold belts and also in Sulaiman fold belt. The Laki Formation correlated with Kirthar Group (Kirthar and Gorag/Gorakh Formations) of western Kirthar and Kahan Group of Sulaiman foldbelt. The Late Eocene-Oligocene Gaj Group represents Late Eocene Nari (sandstone, shale, limestone, ironstone beds) and Gaj (shale with subordinate sandstone and limestone, gypsum bed) formations and Miocene-Pliocene Miocene-Pliocene Manchar Group represented by Litra (dominant sandstone with subordinate shale and negligible conglomerate) and Chaudhwan (dominant shale with subordinate sandstone and minor conglomerate) Formations which are mainly exposed on the eastern foot of Laki Range and also on northern plunges eastern foldbelt (Manchar and its southern vicinity). Pleistocene-Holocene Sakhi Sarwar Group represented by Dada (well developed conglomerate with subordinate mud and sandstone) and Sakhi Sarwar Formation (poorly developed conglomerate with subordinate mud and sandstone, while in centre of valleys, the mud is dominant) rarely exposed in the foot of eastern foldbelt and mostly concealed in plain areas by the Subrecent and Recent (**Figure 9**). The major variation from eastern Kirthar foldbelt (Bara Laki section; **Figure 9**) to western Kirthar fold belt is as follows. The stratigraphy and thicknesses of formations of the Bara Laki section and Pab Range section are almost same. While there are many variations from Bara Laki to Gorakh, Karkh and Kharzan Moola sections. The Pab Sandstone is about 400 - 500 m at Bara Laki and Pab Range while it is decreasing upto a few meters in the Karkh and Kharzan areas of Khuzdar district. Further a small thickness of Eocene Sohnari of eastern Kirthar is replaced by more than 500m thick Shaheed Ghat shale and further northward at Johan the Shaheed Ghat, Toi and Kingri formations are developed. In this way Eocene Laki Formation is replaced by a thick sequence of Kirthar and Gorag Formations.

3.3. New Titanosaurian Sauropods from the Latest Maastrichtian Vitakri Formation of Pakistan

Previously 10 titanosaurs were described from Pakistan ([51] [52] [64] and references therein) and here 3 new titanosaurian sauropods (**Figures 10-14**) are being described based on diagnostic materials collected from lower, mid and upper Sangiali localities. The holotypic and referred materials, informal and formal description year and also other significant information of all these titanosaurs (Balochisaurids (**Table 2**), Gspsaurids (**Table 3**) and Pakisaurids (**Table 4**) are provided in tables for quick overview, while these necessary data of other recently discovered prehistoric biota is available in Tables 5-12 of [27]. *Saraikimasoom* is based on snout; *Gspsaurus*, (*Maojandino*), *Nicksaurus* and *Khanazeem* are based on cranial, vertebral and appendicular elements; *Balochisaurus*, *Marisaurus*, *Pakisaurus, Imrankhanhero, Qaikshaheen* and *Ikqaumishan* based on vertebral and appendicular elements; and *Sulaimanisaurus* and *Khetranisaurus* based on only caudal vertebrae. Most of these titanosaur materials will provide facility for comparison of diagnostic and key elements like cranial, humeri, femora, tibiae and their features [27]. The vertebrae and especially caudal vertebrae affected by series variation may not provide diagnostic features [65]. Further, there are ontogenic observations on tibia [85] and femora and tibia [65]. But here the femora (**Figures 10-12**) and tibiae (**Figure 14**) and many specimens described in previous reports [51] [58] [61] [63] [64] belong to adult animal and have almost the same size which revealed as the variation in these specimens may be taxonomic (and not relevant to ontogenic growth). Top Kinwa braincase (GSP/MSM-2-16 and GSP-UM 7000) (**Table 3**) (**Figure 13**) is being referred to *Gspsaurus pakistani* because this braincase is found with the assemblage of *Gspsaurus pakistani* from Topkinwa (about 10 - 15 m downward from tibia). Further its matrix coating was same greyish black or desert varnish as fibulae and tibia (from Topkinwa) of *Gspsaurus pakistani*. Previously ambiguity was created by misidentification of caudal vertebra as braincase (corrected by Dr. Jeffery A. Wilson Mantilla as anterior caudal vertebra). So now it can be assigned to *Gspsaurus pakistani* due to associated typical tibia and other assemblage of *Gspsaurus pakistani*. Previously Topkinwa braincase was assigned to *Isisaurus colberti* [86] then considering no any associated assemblage. A coracoid GSP/MSM-366-3 (**Figure 13**) (**Table 4**) from Shalghara locality was referred to *Pakisaurus balochistani* [52]. There is a dispute on the morphological variation of dorsal centra [65]. There are many cervical, dorsal and sacral vertebrae found from Pakistan [51] [58] [62] [63] [64] [87]. The anterior dorsal centra are broad and have ventral plain surface due to finding of cervical and cervicodorsal which are broad and have ventral plain surface. The posterior dorsal have ventral keel as it is found in sacral centra [51] [58] [62] [63] [64] [87]. During field visits, many fossil assemblages and numerous isolated bones were observed but left in field for future studies in many localities such as South Sangiali 1, South Kinwa 4s, southwest Kinwa 4s, mid Kinwa 4m, North Kinwa 4n, Top Kinwa 16, south Alam 19 or 19s, central Alam 19 or 19c, and North Alam 19n, east Alam 18 and Dada Pahi 17 (**Figure 4** of [51]: **Figure 1** of [64]; [70]). The south Sangiali locality exposures are found just above the mid Sangiali and then turn toward south and then continue about 0.5 km almost generally north south. The western bank side exposures are significant for further collections. Then the both flank of Kinwa stream (including south Kinwa, southwestern

Kinwa, mid Kinwa, north Kinwa and Topkinwa/eastern Kinwa) is most significant especially western and northern flank. From the upper end of Topkinwa 16, the exposures are bifurcated, one belt go to north, central and south Alam 19 and the other belt go to southeast crossing east Alam 18 and then into Dada Pahi 17 locality. There is also a central ridge with subcircular shape located in the southern part of east Alam locality which has fossils exposures in periphery just below the peak. The localities of titanosaurs along with coexisted theropods and other archosaurs and birds and mammals were described and mapped in (**Figure 4** of [51]: **Figure 1** of [64] [70]). The exposures of K-Pg boundary and Maastrichtian Pab Formation (with Dhaola, Kali and Sor Members) and latest Maastrichtian Vitakri Formation, type localities of different formations are mentioned and mapped in ([26] [51] [52] and references therein).

However, despite the large number of specimens collected from the Vitakri Formation which is basis for numerous species, there is still no complete, intact element known, although there are a few nearly complete snout, braincase, and limb elements that have been reported [65]. In some cases, though, the presence of overlapping partial elements allows reconstruction of a complete element (e.g., proximal limb elements) [65]. The collection of sauropod elements from the Vitakri Formation of Pakistan form the basis for numerous species, but it lacks complete elements and is predominated by caudal centra [65]. It is no doubt the caudal vertebrae are predominant but diversified diagnostic limb bones are common, while cranial elements are very low in quantity but are very significant anatomically. Intact two femora like left femur GSP/MSM-190-4n of *Nicksaurus* from north Kinwa (about 0.85 - 90 cm length), a femur GSP/MSN-168-15 of *Balochisaurus* from southern most site of Mari Bohri (about 1.2m long) were complete but fractured during transportation. An intact humerus (proximal humerus GSP/MSM-202-4, mid humerus GSP/MSM-268-4, distal humerus GSP/MSM-193-4) of *Pakisaurus* found in the field but it is fractured during transportation and may be round about 1 m in length. Further the femur (proximal femur GSP/MSM-595-4 and distal femur GSP/MSM-200-4) of *Pakisaurus* from south Kinwa (1.2 m in length) were nearly complete. The proximal femur GSP/MSM-169-15 and distal femur GSP/MSM-70-15 along with many shaft sections of *Marisaurus* was collected which can be reconstructed as complete or almost complete. This femur is among the heaviest femur found from Pakistan and it may have length 1.3 - 1.5 m. The distal heavy femur (like *Marisaurus*) observed in field (just west of mid Kinwa bend) may belong to collected proximal and mid femur GSP/MSM-208-4 from South Kinwa and it may have length 1.3 - 1.5 m. The femur (proximal and distal femur GSP/MSM-178-2 and GSP/MSM-182-2) of *Qaikshaheen* and femur (proximal and mid femur GSP/MSM-69-2, with distal condyles GSP/MSM-272- 2 and GSP/MSM-265-2) of *Khanazeem* are almost complete and about 75 cm long. The tibia GSP/MSM-186-2 of *Khanazeem* and tibia GSP/MSM-235-7 of *Imrankhanhero* are almost complete (about 65 cm long) and informative. A few vertebrae are almost complete and informative. Some vertebrae of *Gspsaurus* from Alam were complete in the field and fractured in transportation. Numerous large fragments including neural arches of *Gspsaurus* are in the museum but it needs preparation. One snout of *Saraikimasoom* is complete and it provides complete teeth row. Skull of *Gspsaurus* is almost complete which comprises of snout articulated with quadrate and quadratojugal and referred Topkinwa braincase (**Table 3**) (**Figure 13**). Most of the holotypic materials found as assemblages (each of these assemblages belongs to single individual and species) on the surface of the host rock, while at few places bones were also in alignment and at places partially excavated like *Saraikimasoom* snout, femur of *Nicksaurus*, vertebrae were in alignment in *Gspsaurus* vertebrae from Alam and vertebrae of *Qaikshaheen* from mid Bor. The titanosaurian species from Pakistan are proliferated as the theropods from India. Although proliferated most of these have diagnostic cranial and limb key elements and provide a comparison facility due to overlapping elements, especially key elements.

3.3.1. New Titanosaurian Sauropod *Imrankhanhero zilefatmi* from the Latest Maastrichtian Vitakri Formation of Pakistan

Systematic Paleontology

Dinosauria; Saurischia; Sauropoda; Titanosauriformes; Titanosauria; Poripuchia [58] vide [51]; Pakisauridae [56] vide [51]; Isisaurinae [22];

Imrankhanhero zilefatmi new genus and new species (**Figure 10**)

Holotype: Holotype includes a partial right humerus (proximal and mid portion GSP-UM/Sangiali-1124, distal portion GSP/MSM-262-1), distal right femur GSP/MSM-232-1 and proximal right fibula GSP-UM/Sangiali-1117 (**Figure 10**). The specimen proximal and mid-right humerus GSP-UM/Sangiali-1124 is appropriate in size to pertain to the same specimen as the distal right humerus from the same site. Thus, it is plausible that these two specimens pertain to the same individual. Further this holotypic material is found as surface finds in lower Sangiali with size agreement and no duplication shows belong to a single individual. Holotypic fossil housed in museum of Geological Survey of Pakistan, Quetta, Pakistan except the proximal humerus GSP-UM/Sangiali-1124 and proximal fibula GSP-1117 which are hosted now at the Museum of Paleontology, University of Michigan, USA and will return back to its original position in the museum of Geological Survey of Pakistan, Quetta, Pakistan. Beside this holotypic material a few caudal vertebrae were also found in the same site of lower Sangiali locality but not collected (see below). When the mid Sangiali assemblage was taken, at that time a few bones collected from downstream and upstream which were included in mid Sangiali/eastern Sangiali assemblage. The distance between lower and mid Sangiali sites is about 30 - 50 m. The size of proximal right humerus GSP/Sangiali-1124 and right fibula GSP-UM/Sangiali1117 (may be found at downstream and close to the lower Sangiali site) matches with the size of distal humerus GSP/MSM-262-1 and distal femur GSP/MSM-232-1 collected from lower Sangiali and mid caudal centra observed in lower Sangiali/western Sangiali/north Sangiali site (page 68 of [70]). The proximal humerus and fibula may be found associated with distal humerus and distal femur. Reference (page 68 of [70]) mentioned that the Sangiali locality has three main sites from where the dinosaur fossils are found. The western site (lower Sangiali) has associated bones (now holotype of *Imrankhanhero zilefatmi*) along with slightly tall caudals which are hosted in site. The eastern site (mid Sangiali) produced fragmentary but associated about 100 fossils (now holotype and referred materials of *Qaikshaheen masoomniazi*). The southern site (upper Sangiali) represents some fossils (vertebrae and limb bones) of stocky limbed Balochisauridae (page 68 of [70]) which are found as disseminated in the upstream area. Here a humerus may be collected from upstream area of southern Sangiali (nearby to mid Sangiali site) is the holotype (see below) of *Ikqaumishan smqureshi*.

Type locality, horizon and age: Holotype was found in the lower Sangiali locality (Pakistan dinosaur locality 1; shown in **Figure 4** of [51]) at latitude 29.69812N and longitude 69.39860E of Vitakri dome area, Barkhan district, Balochistan Province, Pakistan. Host horizon of holotype is the upper varicolored but dominantly maroon mud caped by upper sandstone unit of Vitakri Formation (Table 1 of [52]) of Fort Munro Group [21] [22] [70]. The age of Pab Formation was considered Maastrichtian based on invertebrate such as *Orbitoides* (*Lepidorbitoides*) *minor* ([88] page 192) and *Globotruncana* aff. *G. linnei*, *Lituola* sp., *Omphalocyclusmacropora*, *Orbitellamedia*, *Orbitoides* sp., and *Siderolites* sp. [42]. According to stratigraphic position and previously well dated Maastrichtian Pab Formation (lower formation) and well-dated Paleocene formations (upper formations), the age of Vitakri Formation considered the latest Maastrichtian ([27] pages 904-905, [49] [50] [51] [58] [59]). The paleogeographic reconstruction indicates that the Kingri coal of Vitakri Formation formed when the area was approximately 9˚S of the equator [89]. Further the Karkh basalt (**Figure 9**) of Early Paleocene Rakhi Gaj Formation shows its source from major episode of Deccan volcanic eruption. The Vitakri Formation has conformable lower contact with the Pab Formation at Vitakri area reveal the latest Maastrichtian or at least late Maastrichtian. Further the finding of dinosaur fossils conveys at least the Vitakri Formation is not Paleocene and confirmed latest Maastrichtian age. The referred fossils from Zubra peak locality (**Figure 1** of [64]) of Pakistan are found from the latest Maastrichtian Vitakri Formation, and referred tibia K 20/321 (Figures 4a, b, of Plate 1 of [77]) and right fibula K 27/489 (Figures 5a, b, of Plate 1 of [77]) from Bara Simla, India [77] reported from latest Maastrichtian Lameta Formation.

Referred specimens: A flattened and transversely compressed almost complete right tibia GSP/MSM-235-7 with anteroposteriorly broad distal tibia, proximal right fibula GSP/MSM-253-7 and right metatarsal GSP/MSM-296-7 are being referred to *Imrankhanhero zilefatmi* (**Figure 10**) (**Table 4**). This referral is based on overlapping fibulae which have the same shape and also appropriate size and features to pertain to the same species. The tibia and metatarsal associated with fibula provide additional informations. These referred material was found from Zubra peak 7 (latitude 29˚43'12"N; longitude 69˚30'16"E) of Dhaola-Gambrak area (shown in **Figure 1** of [64]), Barkhan district, Balochistan, Pakistan. A tibia K 20/321 (Figures 4a, b, of [77]) and right fibula K 27/489 (Figures 5a, b, of [77]) from Bara Simla, Jabalpur, India [77] are being referred to *Imrankhanhero zilefatmi* on shape resembling and size matching with its South Zubra exemplar's tibia and fibula.

Etymology: Genus name *Imrankhanhero* honors the Imran Khan who and whose team won the 92 World Cup, *hero*, for champion and Imran Riaz Khan great journalist and leader of Pakistan to support the poor peoples of Koh Sulaiman Range which are host of fossils. The genus name *Imrankhanhero* can be pronunciated as Imran Khan Hero. The species name *Imrankhanhero zilefatmi* honors the Shaheed Zileshah for his sacrifice and Dr. A. N. Fatmi, Former Deputy Director General, Geological Survey of Pakistan, on his contribution regarding Mesozoic paleontology and stratigraphy of Pakistan. The species name *zilefatmi* can be pronunciated as Zile Fatmi.

Diagnosis: *Imrankhanhero zilefatmi* medium sized sauropod shares with the Titanosauria on the basis of procoelous caudal centra which are found from this locality. It shares with Poripuchia because of sharing with Pakisauridae. It shares with Pakisauridae on the basis of slender femur (**Figure 10**) and slightly tall almost squarish and slender caudal. It has following autapomorphies. The humerus of *Imrankhanhero zilefatmi* is relatively slender, small sized and almost L-shaped. Its humerus has medially inset, sinusoidal and intermediate (between slender and robust) deltopectoral crest and posterior plain surface just below head, while *Qaikshaheen masoomniazi* has almost laterally set, sinusoidal and robust deltopectoral crest and posterior plain surface just below head, *Ikqaumishan smqureshi* has medially inset, slender and almost straight deltopectoral crest and posterior plain surface just below head, *Gspsaurus pakistani* has medially inset, almost straight, slender and a subcircular ridge peak at the base of deltopectoral crest and posterior plain surface just below the head, *Pakisaurus balochistani* has medially inset, robust and almost straight deltopectoral crest and posterior ridge with lateral and medial triceps, and *Balochisaurus malkani* has ventrally shifted head and posterior plain surface just below the head. Its distal humerus has no anteriorly expanded radial condyle like *Isisaurus colberti* while all other titanosaurs from Indo-Pakistan have anteriorly expanded radial condyle. Its distal femoral shaft transverse width is about twice of its anteroposterior width (**Figure 10**). It has slender femur, while *Khanazeem saraikistani*, *Pakisaurus balochistani* and *Gspsaurus pakistani* have more slender femora, *Qaikshaheen masoomniazi* has robust femora, *Balochisaurus malkani* and *Marisaurus jeffi* have more robust femora. A triangular cavity/hallow is found in the core of femoral distal shaft (**Figure 10**). Proximal tibia is extremely slender like

Khanazeem saraikistani, while *Gspsaurus pakistani* has robust proximal tibia and *Balochisaurus malkani* and *Qaikshaheen masoomniazi* has more robust proximal tibia. Its distal tibia is sub-triangular, anteroposteriorly broad and host centrally situated and wide astragalar fossa (**Figure 10**) like *Khanazeem saraikistani*, while *Gspsaurus pakistani*, *Nicksaurus razashahi* and *Balochisaurus malkani* have transversely broad distal tibia with narrow astragalar fossa located in front of small process of distal tibia (**Figure 14**). Its proximal fibula is more large in anteroposterior width, while *Pakisaurus balochistani* fibula is large in anteroposterior width, *Gspsaurus pakistani* and *Qaikshaheen masoomniazi* fibulae are relatively small in anteroposterior width. For more comparison/diagnosis see below.

Description of elements

Caudal vertebrae: A few small caudal centra found with these holotypic materials are procoelous, slightly tall and subsquarish, with slight ventral reduction (almost no ventral reduction) and neural arch was anteriorly set. Its centra were relatively light and flat laterally than the centra of *Qaikshaheen masoomniazi* and *Ikqaumishan smqureshi* and which is heavier and ventrally reduced.

Humerus: A partial right humerus (proximal and mid portion GSP-UM/ Sangiali-1124, distal portion GSP/MSM-262-1) was collected (**Figure 10**). The proximal humerus of *Imrankhanhero zilefatmi* has L-shaped proximal portion while *Isisaurus colberti* has relatively flat proximal humerus [65] [90]. The deltopectoral crest of *Imrankhanhero zilefatmi* is medially inset, intermediate (between robust and slender) and sinusoidal while *Qaikshaheen masoomniazi* has relatively laterally inset, robust and sinusoidal deltopectoral crest and posterior plain surface just below the head, *Ikqaumishan smqureshi* has medially inset, slender and straight deltopectoral crest and posterior plain surface just below the head, *Gspsaurus pakistani* has medially inset, subcircular peak at the base and almost straight deltopectoral crest of proximal humerus, and *Pakisaurus balochistani* has medially inset and almost straight deltopectoral crest and has posterior ridge (flanked by lateral and medial triceps fossae) just below the head. The shaft section just below the deltopectoral crest shows that mediolateral width is slightly more than anteroposterior depth. The distal humerus show posteriorly well concavity for the adjustment of olecranon process of ulna. The distal humerus of *Imrankhanhero zilefatmi* has no anteriorly expanded prominent radial condyle like *Isisaurus colberti* [90], while *Pakisaurus balochistani* has anteriorly expanded radial condyle (third condyle other than medial and lateral condyles) located in the mid of transverse distal width of the distal humerus, *Balochisaurus malkani* has large anteriorly expanded radial condyle which is shifted laterally toward lateral condyle (also flushed with lateral condyle), and *Qaikshaheen masoomniazi* has relatively small anteriorly expanded radial condyle and migrated toward lateral condyle (but not flushed with lateral condyle). Further six morphs of humeri are mentioned (see below).

Femur: A distal femur GSP/MSM-232-1 (**Figure 10**) was collected which preserved significant diagnostic features like its slender nature (transverse width slightly more than twice of anteroposterior width) and a triangular cavity/hallow in the core of shaft. Its triangular small cavity or hollow is not found in any other titanosaurs from Indo-Pakistan. Its femoral triangular small cavity or hollow is differentiated from the large hollow cavity of femora of theropods. But here the peripheral bone is twice to thrice thick than triangular core cavity. The cross section of this distal shaft is large sized which shows subrectangular shape. In contrast, the theropods have circular and subcircular hollow and also relatively small cross-sections of femoral bone. Here the femoral difference of theropods and titanosaurs is mentioned because 3 theropods were reported from Vitakri dome area.

Tibia: An almost complete right tibia (GSP/MSM-235-7) (**Figure 10**, **Figure 14**) collected from Zubra peak. The proximal part of tibia of *Imrankhanhero zilefatmi* is flattened (**Figure 10**, **Figure 14**) like the proximal flattened tibia of *Khanazeem saraikistani* (**Figure 14**) while in contrast the *Gspsaurus pakistani* has robust proximal tibia (anteroposterior width is slightly to one fourth more than its transverse width) (**Figure 14**) and *Balochisaurus malkani* and *Qaikshaheen masoomniazi* have more robust proximal tibia (where the anteroposterior and transverse widths are subequal) (**Figure 14**). The distal tibia of *Imrankhanhero zilefatmi* is subtriangular shaped anteroposteriorly expanded (**Figure 10**, **Figure 14**) like the *Khanazeem saraikistani* (**Figure 14**), while in contrast the *Gspsaurus pakistani, Balochisaurus malkani* and *Nicksaurus razashahi* have transversely expanded and long subparalellogram or suboval shaped distal tibiae (**Figure 14**). The four morphs (or at least three morphs) of tibiae are found in Pakistan which are very significant for taxonomic comparison. The first morph is the more robust morph represented by subequal transverse and anteroposterior widths (and its long subparalellogram or suboval shaped transversely expanded distal tibia with narrow astragalar scar located in front of short distal process) (**Figure 14**) with exemplars as *Balochisaurus malkani* and *Qaikshaheen masoomniazi* (**Figure 11**, **Figure 14**). The second morph is the robust morph represented by anteroposterior width which is round about one and half (1.5) of transverse width, and its long subparalellogram or suboval shaped transversely expanded distal tibia with narrow astragalar scar located in front of short process (**Figure 14**), with exemplar as *Gspsaurus pakistani*. The third morph is the slender morph represented by almost flat tibia which have round about twice anteroposterior width than its transverse width and its subtriangular shaped distal tibia has a more transversely expanded width (than *Imrankhanhero zilefatmi* tibia) and more wide astragalar scar located in the centre of transverse width and also found between the long and short distal processes (**Figure 14**), with exemplar as *Khanazeem saraikistani*. The fourth morph is the slender morph represented by almost flat tibia which have round about twice anteroposterior width than its transverse width and its subtriangular shaped distal tibia has relatively less transversely expanded width (than *Khanazeem saraikistani* tibia) and less wide astragalar scar located in the centre of transverse width and also found between the long and short distal processes (Figure 14), with exemplar as *Imrankhanhero zilefatmi*. According to reference [85] (Figures 1, 2 of Plate 45 of [85]) the *Saltasaurus* juvenile has a more slender tibia than the robust tibia of adult showing ontogenetic growth variations. The author's observations on plates (Figures 1, 2 of Plate 45 of [85]) of juvenile and adult tibiae of *Saltasaurus* which show little variation but both grouped in robust morph (as mentioned above). So no major ontogenetic changes are found in tibiae morphs. The more robust morph of tibiae is also preserved for adult *Lohuecotitan pandafilandi* [91] from upper Cretaceous of Spain, *Lusotitan atalaiensis* [92] from late Jurassic of Portugal and *Diamantinasaurus matildae* [93] [94] from mid-Cretaceous of Australia but unluckily the tibia of Upper Cretaceous juvenile *Diamantinasaurus matildae* [95] was not recovered. The above 4 morphs reported belong to adult individuals and most of them have almost same size which revealing taxonomic variations (and not ontogenetic growth variation).

Further on observing the cross-section of proximal shafts (Figure 14) of tibiae, there are three prominent morphs of tibiae from Pakistan appeared. The first more robust morph has balloon shaped shaft (Figure 14) with strongly thick posterior portions (and thin anterior portions) with exemplars *Qaikshaheen masoomniazi* and *Balochisaurus malkani* (Figure 14). The second robust morph has anticlinal shaped (Figure 14) proximal shaft with central portion thicker than anterior and posterior ends of shaft cross section, with exemplar *Gspsaurus pakistani* (Figure 14). The third slender morph has oval shaped proximal shaft with subequal thickness at anterior and posterior ends of shaft cross-section (Figure 14) with exemplars *Imrankhanhero zilefatmi* and *Khanazeem saraikistani* (Figure 14). All these shafts cross sections were anteroposteriorly long. From Pakistan these 3 morphs reported belong to adult individuals and most of them have almost the same size which revealing taxonomic variations (and not ontogenetic growth variation).

Fibula: The proximal right fibulae GSP-UM/Sangiali-1117 (Figure 10) from lower Sangiali and GSP/MSM-253-7 (Figure 10) from Zubra peak were collected. These proximal fibulae of *Imrankhanhero zilefatmi* are relatively long/large anteroposterior width than intermediate fibula (between small and long anteroposterior widths) of *Pakisaurus balochistani* and small fibula (anteroposteriorly expansion is relatively small) of *Gspsaurus pakistani* and *Qaikshaheen masoomniazi.* The proximal fibula of *Imrankhanhero zilefatmi* has relatively smooth lateral and medial sides and has no dorsoventral subparallel fibrous rugosities on the lateral and medial sides (Figure 10), while *Pakisaurus balochistani* fibula has dorsoventral subparallel fibrous rugosities on the lateral and medial sides. The 3 morphs based on size of anteroposterior expansion of fibulae collected from Pakistan. The first more large morph fibula (Figure 10) (more long anteroposterior expansion) with exemplar is *Imrankhanhero zilefatmi*. The second large morph fibula (long anteroposterior expansion) with exemplar is

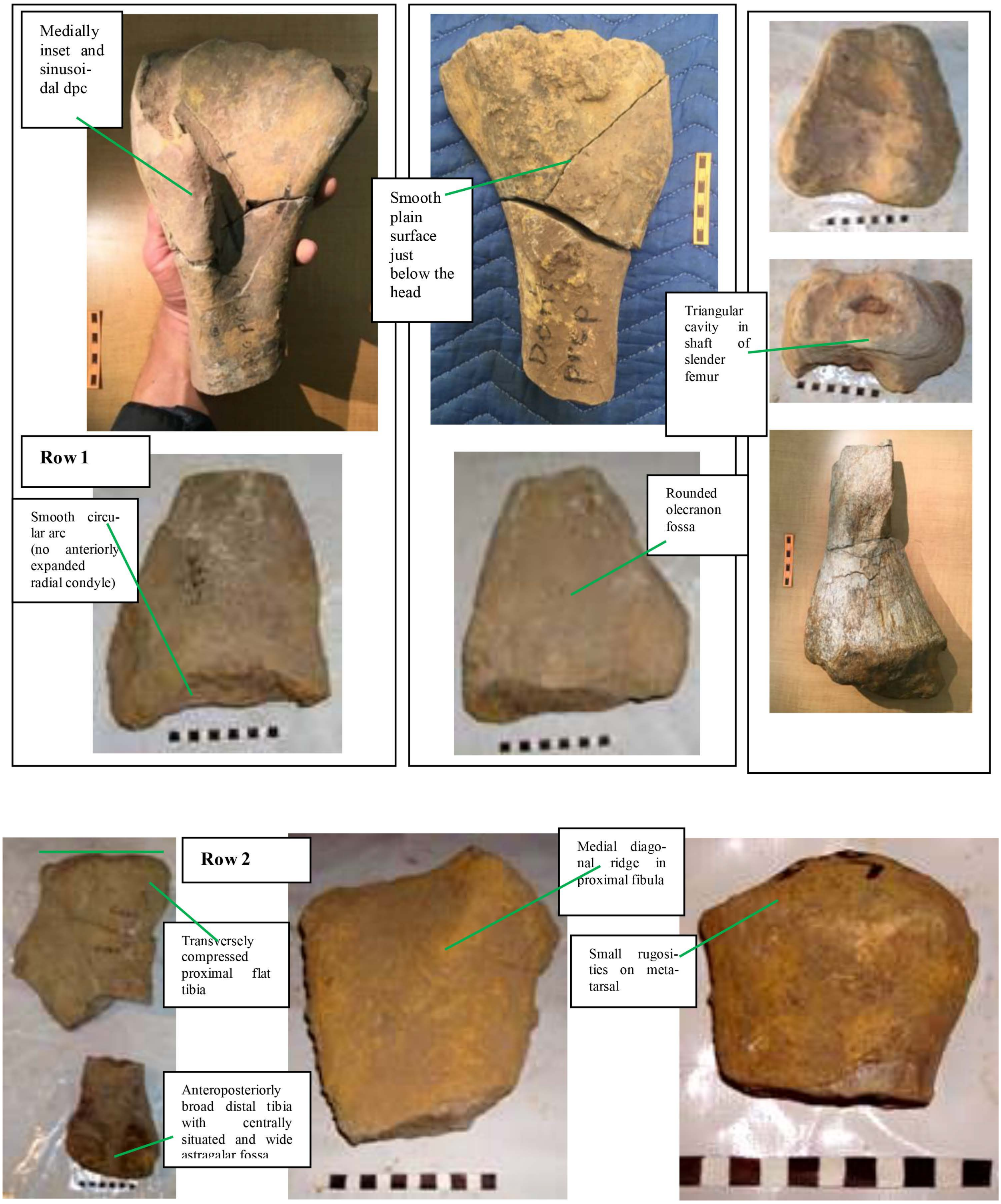

Figure 10. *Imrankhanhero zilefatmi* holotypic specimen (Row 1, plates/column 1,2,3) found from lower Sangiali locality (Figure 4 of [51]) and referred specimen (Row 2, plate/column 1,2,3) found from Zubra peak locality (Figure 1 of [64]), Barkhan District, Balochistan Province, Pakistan. **Row 1, plates/column 1,2,** A partial humerus (GSP-UM/Sangiali-1124; GSP/MSM-262-1) in anterior (column 1) and posterior (column 2) views; **plates/column 3,** upper and middle images, distal femur GSP/MSM-232-1 in dorsal and posterior views, and lower image, proximal right fibula GSP-UM/Sangiali-1117. **Row 2, plate/column1,** flattened and transversely compressed right tibia MSM-235-7 with anteroposteriorly broad distal tibia; **plate 2,** proximal right fibula MSM-253-7; **plate 3,** right metatarsal MSM-296-7. Scale each black or white/yellow digit is 1 cm.

Pakisaurus balochistani. The third small morph fibula (small or less anteroposterior expansion) with exemplars is *Qaikshaheen masoomniazi* and *Gspsaurus pakistani*. All these morphs of fibulae have medial diagonal ridge (**Figure 10**). Here only size of fibula is indicator.

Qaikshaheen masoomniazi has lesser anteroposteriorly width (about 12cm) proximal fibula from mid Sangiali like those of *Gspsaurus pakistani* has about 13-14cm proximal fibula from Top Kinwa, while *Pakisaurus balochistani* has larger anteroposteriorly width (about 15cm) proximal fibula from south Kinwa, and *Imrankhanhero zilefatmi* has more larger anteroposteriorly width (about 18cm) proximal fibula from lower Sangiali and anteroposteriorly width (about 25cm) from Bara Simla. This revealed that the relatively less anteroposterior width bearing proximal fibulae adjusted withmore robust and more transversely expanded proximal tibiae (anteroposterior width is subequal with transverse width), the intermediate anteroposterior width bearing fibulae are adjusted with robust and intermediately transversely expanded proximal tibiae (anteroposterior width is 1.5 of transverse width), and the more larger anteroposterior width bearing fibulae are adjusted with slender and almost flat proximal tibiae (anteroposterior width is twice or more of transverse width). This indicates that the more robust and stronger tibiae are balanced by weak fibulae, the robust and strong tibiae are balanced by intermediate (between weak and strong) fibulae, and the slender tibiae are balanced by strong and robust fibulae to adjust and balance support for body weight.

The shape and size of Chhota Simla fibula resemble with *Gspsaurus pakistani* Topkinwa left and right fibulae. The references ([27], table 3), ([51], page 289), ([52], page 1045) ([62], pages 458-460)and ([51], page 422) referred Chhota Simla skeleton to *Gspsaurus pakistani* on shape resembling of key tibia. But now it is further verified by shape and size resemblance theTopkinwa left and right fibulae with the Chhota Simla left fibula. Now it is plausible that the Chhota Simla limb skeleton is referable to *Gspsaurus pakistani*. Further the reference ([96], page 993) describing the Chhota Simla fibula, claimed in 2011 that only one other fibula [77] has been reported from the Cretaceous of Indo-Pakistan. It seems mistype. While in actual (a pair) left and right proximal fibulaeGSP/MSM-76-16 and GSP/MSM-77-16 were already reported and figured in 2006 (Figure 19b on page 128 of [56]). Further one author (JAW) also observed these pair of fibulae in 2001 in the museum of Geological Survey of Pakistan, Quetta.

Metatarsal: A partial metatarsal GSP/MSM-296-7 (**Figure 10**) was collected from Zubra peak area with tibia and fibula within about 2 m length. It is triangular and robust. It has no rugosity which represents it may be a distal metacarpal.

3.3.2. New Titanosaurian Sauropod *Qaikshaheen masoomniazi* from the Latest Maastrichtian Vitakri Formation of Pakistan

Systematic Paleontology

Dinosauria; Saurischia; Sauropoda; Titanosauriformes; Titanosauria; Poripuchia [58] vide [51]; Balochisauridae [56] vide [64]; Balochisaurinae [22].

Qaikshaheen masoomniazi new genus and new species (**Figure 11**) (**Figure 12**).

Holotype: Holotype includes partial posterior cervical centrum GSP-UM/Sangiali-1101, partial cervicodorsal centrum GSP-UM/Sangiali-1176, three partial dorsal vertebrae GSP-UM/Sangiali-1102, GSP-UM/Sangiali-1103 and GSP-UM/Sangiali-1123, dorsal neural arch GSP-UM/Sangiali-1104, three partial caudal vertebrae GSP-UM/Sangiali-1105, GSP-UM/Sangiali-1106, and GSP-UM/Sangiali-1107, distal scapula in 2 pieces GSP-UM/Sangiali-1108 and GSP-UM/Sangiali-1109, and mid scapula GSP-UM/Sangiali-1110; proximal left scapula GSP-UM/Sangiali-1111; left coracoid GSP-UM/Sangiali-1112; proximal right humerus GSP-UM/Sangiali-1113; humerus cross section GSP-UM/Sangiali-1114; distal right humerus GSP-UM/Sangiali-1115; partial ischium GSP-UM/Sangiali-1116; proximal left femur GSP-UM/Sangiali-1118; left distal femur GSP/MSM-1-1; right proximal and mid femur GSP-UM/Sangiali-1119; left proximal tibia GSP-UM/Sangiali-1120; proximal left fibula GSP-UM/Sangiali-1121; mid left fibula GSP-UM/Sangiali-1122 (**Figure 11**). This assemblage found as surface (10 m * 5 m area) at the single site, size matches (size agreement among holotypic elements) and no duplication among these holotypic elements, show association of a single individual. Fossils are housed in museum of Geological Survey of Pakistan, Quetta, Pakistan but now present at the Museum of Paleontology, University of Michigan, USA and will return back to its original position in the museum of Geological Survey of Pakistan, Quetta, Pakistan. Reference (page 68 of [70]) mentioned the collection from 3 sites of Sangiali Locality 1 (see above).

Type locality, horizon and age: Holotype was found in the mid Sangiali locality (Pakistan dinosaur locality 1) with an area of about 10 m long and 5 m wide area bounded by latitudes 29.69810N and 29.69812N and longitudes 69.39872E and 69.39882E (shown in **Figure 4** of [51]) of Vitakri dome area, Barkhan district, Balochistan Province, Pakistan. This type locality is found in the northern part of Vitakri dome. Host horizon of holotype is the upper varicolored but dominantly maroon mud caped by upper sandstone unit of Vitakri Formation (Table 1 of [52]) of Fort Munro Group [21] [22] [70]. According to stratigraphic position and previously well-dated Maastrichtian Pab Formation (lower formation) and well-dated Paleocene formations (upper formations), the age of Vitakri Formation considered the latest Maastrichtian ([27] pages 904-905, [49] [50] [51] [58] [89]). For detail please see above. The referred fossil assemblage from mid Bor locality (**Figure 4** of [51]) of Pakistan is found from the latest Maastrichtian Vitakri Formation, and referred right humerus from Bara Simla locality, Jabalpur, India (Figures 2a, b, of Plate 5 of [77]) and referred right humerus from Rahioli locality, Gujarat state, India (GSI 20012, **Figure 4** of Plate 1 of [78]) and referred femur GSI/WR/M-90-84 from Rahioli, western India [65] [78] [79] are reported from the latest Maastrichtian Lameta Formation.

Referred specimens: The referred materials from mid Bor locality (shown in **Figure 4** of [51]) consists of cervical vertebra GSP/MSM-359-2, cervicodorsal vertebra GSP/MSM-120-2, distal part of cervical rib GSP/MSM-187-2, dorsal vertebrae GSP/MSM-121-2, distal thoracic rib GSP/MSM-301-2, GSP/MSM-122-2, GSP/MSM-123-2, GSP/MSM-124-2, GSP/MSM-125-2, GSP/MSM-441-2, a pair of sacral vertebrae GSP/MSM-135-2, caudal vertebrae GSP/MSM-41-2 and GSP/MSM-42-2, GSP/MSM-360-2, GSP/MSM-302-2, neural spine GSP/MSM-792-2, distal rib/neural spine GSP/MSM-784-2, prezygapophyses and postzygapophyses GSP/MSM-560-2; parts of sternal GSP/MSM-565-2 and GSP/MSM-1004-2, a coracoid GSP/MSM-560-2, humerus parts GSP/MSM-559-2, GSP/MSM-287-2, GSP/MSM-363-2, GSP/MSM-362-2; left and right ulnae GSP/MSM-573-2 and GSP/MSM-271-2, distal ulna GSP/MSM-852-2; proximal metacarpals GSP/MSM-295-2, GSP/MSM-279-2, GSP/MSM-685-2, GSP/MSM-566-2, GSP/MSM-278-2, GSP/MSM-686-2, GSP/MSM-1029-2, GSP/MSM-688-2; distal metacarpals GSP/MSM-277-2, GSP/MSM-1028-2, GSP/MSM-285-2, GSP/MSM-370-2, GSP/MSM-684-2, GSP/MSM-687-2, GSP/MSM-361-2, GSP/MSM-683-2, proximal ischium GSP/MSM-184-2, a femur (proximal half GSP/MSM-178-2 and distal half GSP/MSM-182-2), and metatarsals GSP/MSM-643-2, GSP/MSM-1031-2 and GSP/MSM-1030-2 (**Figure 12**). These fossils are housed in the Museum of Geological Survey of Pakistan, Quetta, Pakistan. The mid Bor Pakistani assemblage is referred to *Qaikshaheen masoomniazi* due to overlapping typical robust femur and vertebrae with appropriate size and shape resembling. The mid Bor assemblage belongs to plausibly a single individual and a single species based on size agreement and finding within about 10*3m area. A femur GSI/WR/M-90-84 from Rahioli, western India [65] [78] [79] is being referred to Qaikshaheen masoomniazi due to shape resembling and appropriate size. A right humerus from Bara Simla, Jabalpur, India (Figures 2a, b, of Plate V of [77] and a humerus from Rahioli, Gujarat state, India (GSI 20012, **Figure 4** of Plate 1 of [78]) are being referred to *Qaikshaheen masoomniazi* due to overlapping humeri and also shape resembling and appropriate size.

Etymology: Genus name *Qaikshaheen* honors the Qaed AllamaIqbal and Imran Khan, abbreviated as Qaik (QAIK), *shaheen,* Urdu/Saraiki for king. The genus name *Qaikshaheen* can be pronunciated as Qaik, Shaheen. Here honored are Allama Iqbal great leader of Pakistan, and both Imran Khan Former Prime Minister of Pakistan and Imran Riaz Khan great journalist and leader to support poor peoples of Sulaiman fold belt which host these fossils. The species name *Qaikshaheen masoomniazi* is after the *masoom*, Urdu/Saraiki for innocent, *niazi*, after the honorable Former Prime Minister of Pakistan who supported the poor peoples of Koh Sulaiman area (host of bones). The species name *masoomniazi* can be pronunciated as Masoom-Niazi.

Diagnosis: *Qaikshaheen masoomniazi* medium sized sauropod shares with the Titanosauria as procoelous caudals and anteriorly oriented neural arch. It shares with Poripuchia (all tail have procoelous centra) due to finding of procoelous distalmost caudals besides anterior, mid and posterior procoelous tail vertebrae. *Qaikshaheen masoomniazi* diagnosed as below. *Qaikshaheen ma-*

soomniazi has proximal scapula (including glenoid and adjoining part) with almost straight alignment and trend with shaft, while *Pakisaurus balochistani* has laterally or outwardly deflected proximal scapula. Its coracoid has no lip while *Pakisaurus balochistani* coracoid has lip (**Figure 13**). Its proximal humerus has almost laterally inset robust deltopectoral crest (**Figure 11**) which is not found in any titanosaurs especially from Indo-Pakistan (comparison see in description). It has robust femur (**Figure 11**) (**Figure 12**) while *Balochisaurus* has more robust femur, and *Imrankhanhero zilefatmi*, *Gspsaurus pakistani*, *Pakisaurus balochistani* and *Khanazeem saraikistani* have more slender femora. Its femoral head is slightly inclined dorsally like *Gspsaurus pakistani*, *Nicksaurus razashahi, Balochisaurus malkani* and *Qaikshaheen masoomniazi*, while *Pakisaurus balochistani* and *Khanazeem saraikistani* have strongly inflected and inclined upward head. Its proximal femur has a straight profile of lateral deflection like *Gspsaurus pakistani*, *Balochisaurus malkani* and *Nicksaurus razashahi*, while *Khanazeem saraikistani* has lateral concavity between the head and lateral bulge of proximal femur. Its proximal tibia is more robust like *Balochisaurus malkani*, while *Gspsaurus pakistani* has robust and *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have slender and flat tibiae. For detail comparison of tibia and other elements, see below.

Description of elements

Vertebrae: The cervicals are opisthotic, broad transversely and ventral smooth surface like the cervicals of *Gspsaurus pakistani*. Its cervicals are relatively smaller than the *Gspsaurus pakistani* cervicals. Cervical rib is broad V-shaped. Its dorsals are opisthotic, slightly transversely broad and have smooth surface in anterior dorsal and has ventral ridge in posterior dorsal. It is believed that the dorsal with smooth ventral surface is found in the anterior and may be in mid, while ventral keel ridge is found in the posterior dorsal deduced from sacral vertebrae which have ventral keel. Its sacral vertebrae are broad, pneumatic and have ventral keel. Its caudals are procoelous, short and have significant ventral reductions (**Figure 11**) (**Figure 12**). Its distalmost caudals (**Figure 12**) are procoelous and grouped in Poripuchian titanosaurs. Lithostrotian did not have procoelous distalmost caudals while Poripuchian had all tail procoelous and more or most derived titanosaurs. Further the reference ([97], page 19) mentioned in 2019 "Regardless of the taxonomic validity of the named Pakistani species a considerable amount of titanosaur materials has been collected from the Pab Formation by the Geological Survey of Pakistan. Of the elements that have been published and the unpublished elements from Pakistan, that we have studied first hand, there are no anterior caudal vertebra and only one anterior dorsal vertebra that is directly comparable to the Indian elements described here" ([97], page 19). Their claim [97] for no any anterior caudal reported from Pakistan is mistyped. While in actual anterior caudal vertebra GSP/MSM-43-15 of*Balochisaurus malkani* (Figures 9-12 of [56] and GSP/MSM-11-4 of *Pakisaurus balochistani* (Figures 5-8 of [56] and GSP/MSM-23-3 and GSP/MSM-24-15 of *Sulaimanisaurus gingerichi*were already reported and figured in 2006 [56] and GSP/MSM-219-19 and MSM-218-19 of *Maojandino alami* [61] and GSP/MSM-347-4n and GSP/MSM- 348-4n of *Nicksaurus razashahi* [61]. Further their claim that only one anterior dorsal vertebra from Pakistan is again mistyped. Some dorsal vertebrae along with cervical and sacral vertebrae were also reported from Pakistan in 2006 [87].

Scapula: *Qaikshaheen masoomniazi* has proximal scapula (**Figure 11**) with almost straight alignment with mid shaft like *Nicksaurus razashahi* and *Gspsaurus pakistani*, while *Pakisaurus balochistani* has laterally or outward deflected proximal scapula from mid-shaft. Its distal scapular blade is plate-like like while mid slightly concaved.

Coracoid: The glenoid of coracoid of *Qaikshaheen masoomniazi* has no lip (**Figure 11**), while *Pakisaurus balochistani* coracoid has lip (**Figure 13**).

Humerus: Its proximal humerus (**Figure 11**) has medially inset (relatively close to lateral end) of ventral end of deltopectoral crest, while laterally set and flushed with lateral humerus of mid deltopectoral crest and turned slightly to medial its proximal portion, as a whole resulting sinusoidal/wavy nature. These features are nor known in other Titanosaurs from Indo-Pakistan subcontinent. Its deltopectoral crest is robust. The *Qaikshaheen masoomniazi* has almost laterally inset, robust and sinusoidal deltopectoral crest and posteriorly plain surface (**Figure 11**), while *Ikqaumishan smqureshi* has medially inset, slender and straight deltopectoral crest and posterior plain surface just below the head and prominent medial process of proximal humerus, *Gspsaurus pakistani* has medially inset, a ridge in the base and straight deltopectoral crest, *Isisaurus colberti* has medially inset deltopectoral crest and *Pakisaurus balochistani* from Pakistan and *Diamantinasaurus matildae* from Australia [93] [94] [95] and *Rapetosaurus krausei* from Madagascar [98] has medially inset and straight deltopectoral crest and posterior mid ridge and triangular shape of shaft cross section just below the deltopectoral crest of proximal humerus. Its distal humerus has expanded radial condyle but shape and position is different than *Pakisaurus balochistani* and *Balochisaurus malkani* (**Figure 2** of **[52]**). Its radial condyle is relatively small and positioned just close to lateral small condyle (**Figure 11**), while *Pakisaurus balochistani* radial condyle is positioned almost in the centre of distal transversal profile (**Figure 2** of [52]) and *Balochisaurus* has relatively large radial condyle positioned just close to lateral small condyle (**Figure 2** of [52]). The sixth morph of humeri are presented as below.

Ulna: A pair of proximal ulnae GSP/MSM-573-2 and GSP/MSM-271-2 (**Figure 12**) collected from mid Bor locality assemblage. The proximal ulna is rugose and bears a prominent olecranon process. The proximal ulna represents a triradiate structure. The ulna is gracile. There is a marked concavity on the proximal lateral side for the adjustment of radius. It has also concavity on the medial side and a relatively small concavity on the posterior side. The relative length of ulnar proximal condylar processes is unequal. Many ulnae were collected from Pakistan but provide no taxonomic major differentiations.

Metacarpals: Many metacarpals were collected from mid Bor (**Figure 12**). Metacarpals are elongated and robust. Distal and proximal condyles are not divided.

Ischium: Partial ischium GSP/MSM-184-2 (**Figure 12**) is found from mid Bor locality. The proximal part is thin and platy having iliac condyle, and long and thin acetabular glenoid and then articular surface for pubis. It is only first ischium found from Pakistan. This ischium is remarkably slender than the ischium of *Isisaurus colberti* [90]. This ischium has low pubis and iliac peduncle. Further theanteroposterior width of pubis and iliac peduncle are almost subeaqual.Its anteroposteriorly width of iliac peduncle is 12 cm, acetabular glenoid is 21cm and pubic peduncle is 12 cm. Its maximum ateroposterior width at the base of iliac and pubic peduncle is about 30 cm. This maximum thickness is ventrally being reduced. It became anteroposterior 18 cm, just 12 cm below the ventral border of iliac and pubic peduncle.Its acetabular glenoid is concave shaped. It is a generally fan shape. Its anteroposterior width of pubic attachment is small or narrow (12 cm), while the *Rapetosaurus krausei*has relatively long anteroposterior width [98].

Femur: Its femora are robust (**Figure 11**) (**Figure 12**) while *Balochisaurus malkani* has more robust femur, and *Pakisaurus balochistani, Khanazeem saraikistani, Imrankhanhero zilefatmi* and *Gspsaurus pakistani* have more slender femora. Its femoral head is slightly inclined like *Gspsaurus pakistani, Balochisaurus malkani* and *Nicksaurus razashahi* while *Pakisaurus balochistani* and *Khanazeem saraikistani* has strongly inflected and inclined upward head. Its dorsolateral corner is straight like *Gspsaurus pakistani, Balochisaurus malkani* and *Nicksaurus razashahi,* while *Khanazeem saraikistani* has a concavity between the posterolateral corner and lateral buldge. For comparison the three morphs of femora (based on slenderness/robustness) found from Pakistan are being presented here. The more robust morph of femur is represented by transverse width considerably less than twice of anteroposteriorly width, with exemplars from Pakistan are *Balochisaurus malkani* (and may be *Marisaurus jeffi* and *Nicksaurus razashahi*). The robust morph of femur is represented by transverse width slightly less than twice of anteroposteriorly width, with exemplars from Pakistan are *Qaikshaheen masoomniazi*. The slender morph of femur is represented by transverse width equal or more than twice of anteroposteriorly width, with exemplars from Pakistan are *Gspsaurus pakistani, Pakisaurus balochistani, Khanazeem saraikistani* and possibly *Imrankhanhero zilefatmi*.

Tibia: The preserved left proximal tibia (GSP-UM/Sangiali-1120) of *Qaikshaheen masoomniazi* shows more robust morph and its cross section in the proximal shaft show balloon shaped with posterior portion strongly more thick than anterior end of cross section of shaft (**Figure 11**, **Figure 14**). The base of its cnemial crest is relatively thick. The tibia of *Qaikshaheen masoomniazi* (**Figure 11**, **Figure 14**) is more robust and heavy like the tibia of *Balochisaurus malkani,*

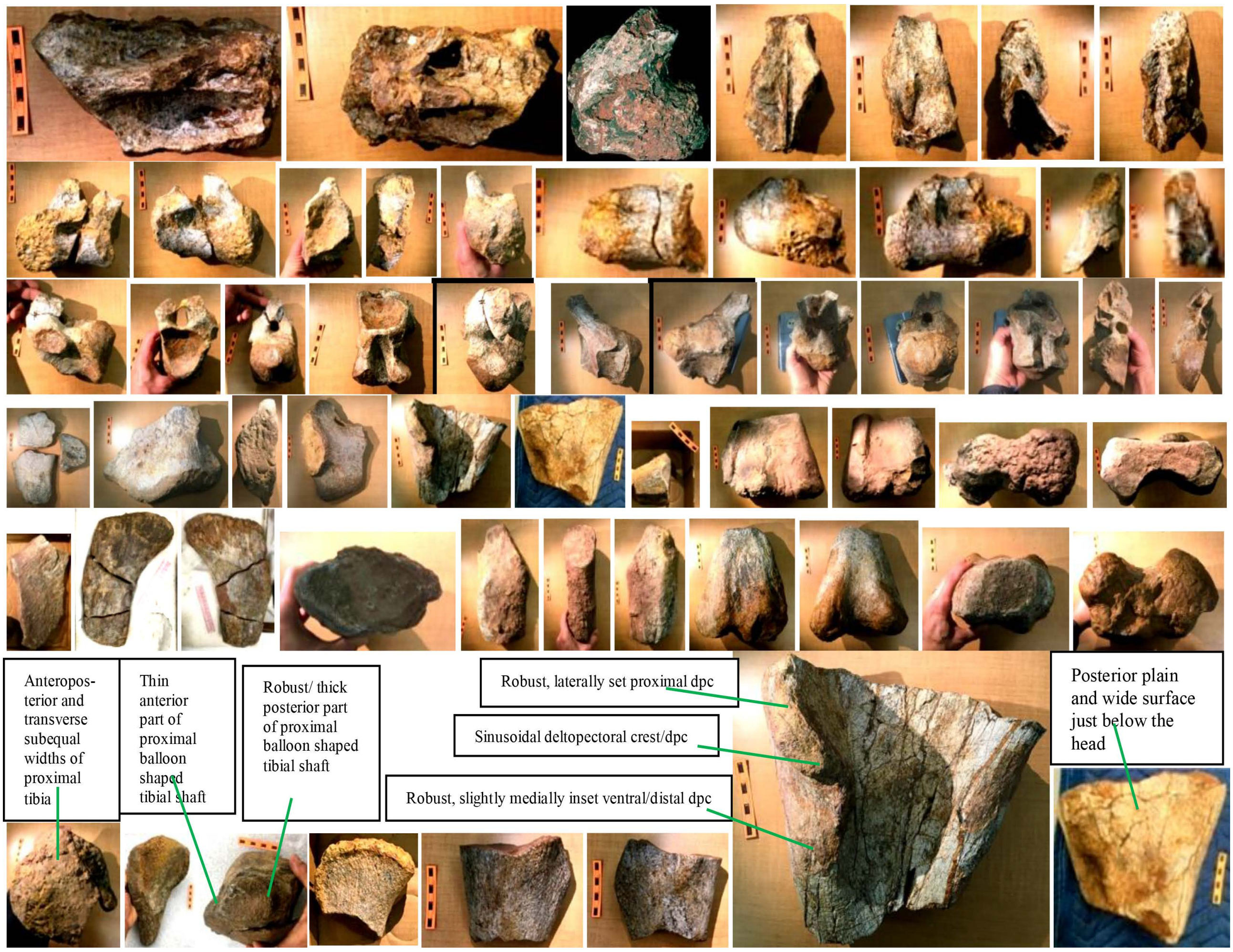

Figure 11. *Qaikshaheen masoomniazi* holotypic fossils from mid Sangiali locality (**Figure 4** of [51]) of Vitakri dome, Barkhan District, Balochistan Province, Pakistan. **Row 1**, Cervical and cervicodorsal vertebrae GSP-UM/Sangiali-1101 and GSP-UM/ Sangiali-1176); an anterior dorsal centrum GSP-UM/Sangiali-1103; dorsal vertebral neural arch GSP-UM/Sangiali-1104 in 4 views. **Row 2**, mid to posterior dorsal centra GSP-UM/Sangiali-1102 and GSP-UM/Sangiali-1123 in 5 views. **Row 3**, caudal vertebra GSP-UM/Sangiali-1105 and GSP-UM/Sangiali-1106 in 5 views; caudal vertebra GSP-UM/Sangiali-1107 in 2 views. **Row 4**, distal scapula in 2 pieces GSP-UM/Sangiali-1108 (upper left) and GSP-UM/Sangiali-1109 (upper right), and mid scapula GSP-UM/ Sangiali-1110 (lower); proximal left scapula GSP-UM/Sangiali-1111 in 2 views; left Coracoid GSP-UM/Sangiali-1112; proximal right humerus GSP-UM/Sangiali-1113 in 2 views; humerus cross section GSP-UM/Sangiali-1114; distal right humerus GSP-UM/ Sangiali-1115 in 4 views. **Row 5**, partial ischium GSP-UM/Sangiali-1116; proximal left femur GSP-UM /Sangiali-1118 in posterior and anterior views; right proximal and mid femur GSP-UM /Sangiali-1119 in 4 views; left distal femur GSP/MSM-1-1 in 4 views. **Row 6**, left proximal tibia GSP-UM/Sangiali-1120 in 3 views. Proximal left fibula GSP-UM/Sangiali-1121; mid left fibula GSP-UM/Sangiali-1122 in 2 views; proximal right humerus GSP-UM/Sangiali-1113 in anterior and posterior views. Scale each black or yellow unit is 1 cm (total scale 7 cm), while in proximal femur scale is total 15 cm or 6 inches.

while *Gspsaurus pakistani* has robust (**Figure 14**) and *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have slender flat tibiae (**Figure 14**). Its four morphs are described above. Its proximal tibia is extremely transversely expanded approaching to its subequal transverse and anteroposterior widths (**Figure 14**) like *Balochisaurus malkani* (**Figure 14**) from latest Cretaceous of Pakistan, *Lohuecotitan pandafilandi* [91] from upper Cretaceous of Spain, *Lusotitan atalaiensis* [92] from late Jurassic of Portugal, and *Diamantinasaurus matildae*

Figure 12. *Qaikshaheen masoomniazi* referred assemblage from mid Bor locality (shown in Figure 4 of [11]), Barkhan district, Balochistan, Pakistan. **(A) Row 1**, cervicodorsal vertebra GSP/MSM-120-2 and dorsal vertebrae GSP/MSM-121-2, GSP/MSM-122-2, GSP/MSM-123-2, GSP/MSM-124-2, GSP/MSM-125-2 in 3 views. **Row 2**, p1, cervical vertebra GSP/MSM-359-2, dorsal vertebra GSP/MSM-441-2; p2,3,4, a pair of sacral vertebrae GSP/MSM-135-2 in 3 views; p5,6,7, caudal vertebrae GSP/MSM-41-2 and GSP/MSM-42-2 in lateral, posterior and ventral views; p8, caudal vertebra GSP/MSM-360-2; p9, trirays distal caudal centrum GSP/MSM-302-2. **(B) column 1**, a femur (proximal and distal femur GSP/MSM-178-2 and GSP/MSM-182-2); **column 2**, proximal ulna GSP/MSM-573-2, proximal ulna GSP/MSM-271-2, and proximal ischium GSP/MSM-184-2; **column 3**, mid-shaft humeral cross section GSP/MSM-559-2; humerus part GSP/MSM-287-2; distal ulna GSP/MSM-852-2; **column 4**, partial proximal humerus/ilium GSP/MSM-363-2; distal humerus GSP/MSM-362-2. **(C) p1**, anterolateral part of sternal GSP/MSM-565-2 and sternal part GSP/MSM-1004-2; **p2**, prezygapophyses and postzygapophyses or coracoid GSP/MSM-560-2; **p3**, distal part of cervical rib GSP/MSM-187-2; p4, distal dorsal rib GSP/MSM-301-2; **p5**, neural spine GSP/MSM-792-2; **p6**, distal rib/neural spine GSP/MSM-784-2; **p7**, subrow 1, proximal metacarpals GSP/MSM-295-2, GSP/MSM-279-2, GSP/MSM-685-2, GSP/MSM-566-2, GSP/MSM-278-2, GSP/MSM-686-2, GSP/MSM-1029-2, GSP/MSM-688-2; subrow 2, distal metacarpals GSP/MSM-277-2, GSP/ MSM-1028-2, GSP/MSM-285-2, GSP/MSM-370-2, GSP/MSM-684-2, GSP/MSM-687-2, GSP/MSM-361-2, GSP/MSM-683-2; **p8**, metatarsal GSP/MSM-643-2 (upper), and metatarsals GSP/MSM-1031-2 and GSP/MSM-1030-2 (lower). Scale each black digit is 1cm. For other scale pl. see [62].

[93] [94] from mid Cretaceous of Australia; while *Gspsaurus pakistani* has intermediately expanded proximal tibia with anteroposterior width is round about

one and half (1.5) of transverse width (Figure 14), and *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have flat proximal tibia with strongly twice anteroposterior width than transverse width (Figure 14).

Fibula: Its fibula (Figure 11) has relatively small anteroposterior width like the fibulae of *Gspsaurus pakistani,* while *Pakisaurus balochistani* has relatively intermediate width (between small and long/larger anteroposterior widths) of proximal fibula, and *Imrankhanhero zilefatmi* has long/larger anteroposterior width of proximal fibula. For detail see above.

Metatarsals: Many metatarsals were collected from mid Bor (Figure 12). Metatarsals are elongated, broad and have rugose articular surfaces. Distal condyle is wide, have rugosities and shape is slightly divided and has central concavity

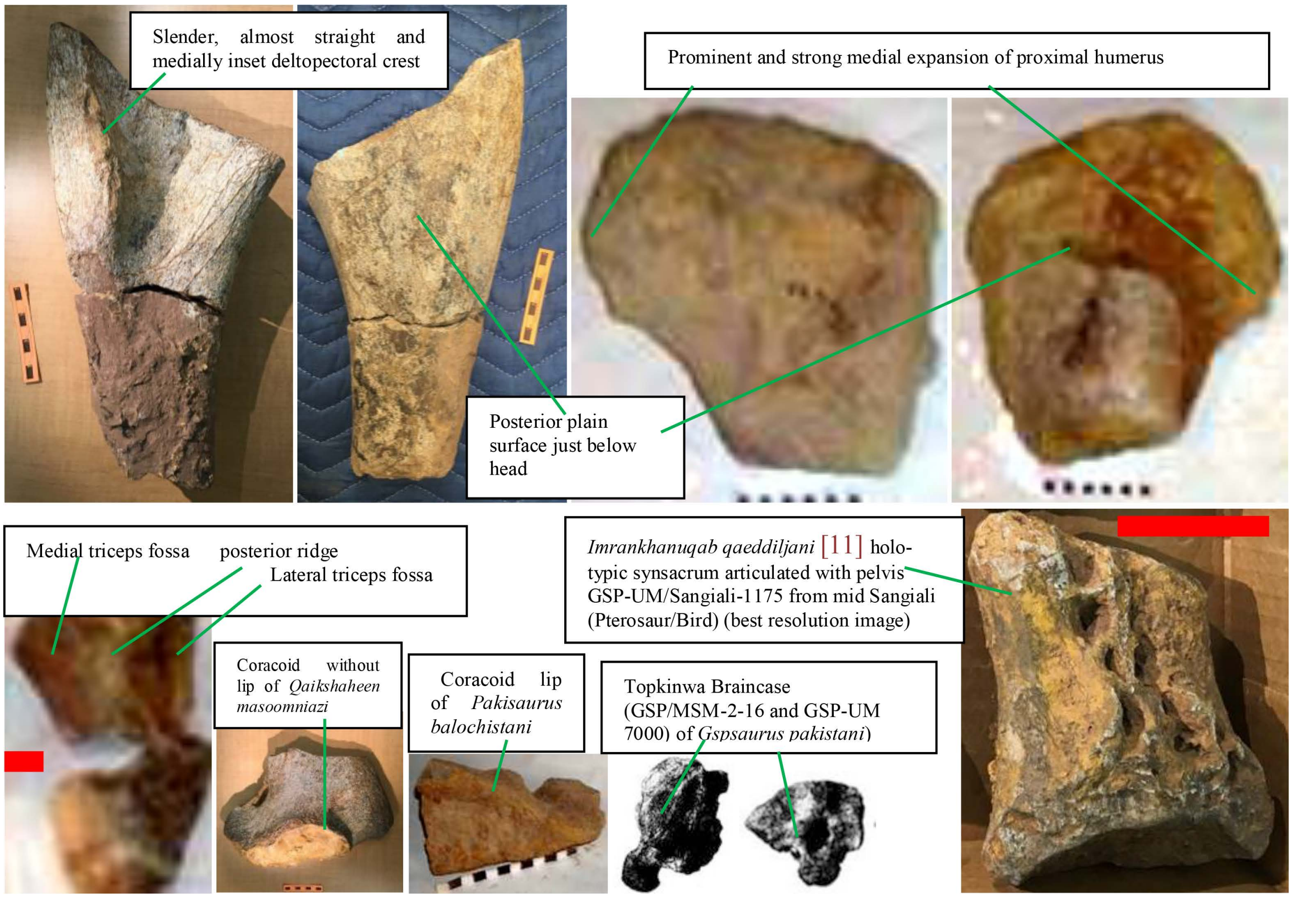

Figure 13. **Row 1,** *Ikqaumishan smqureshi* holotypic (plates 1,2) and referred (plates 3,4). Holotypic partial humerus (GSP-UM/Sangiali-1125; in two views) of *Ikqaumishan smqureshi* found from upper Sangiali locality (just above or south of mid Sangiali shown in Figure 4 of [51]), Vitakri dome area, Barkhan District, Balochistan Province, Pakistan. Referred partial humerus GSP/MSM-237-10 from Rahi Wali locality (shown in Figure 1 of [64]) of Dhaola Range, Barkhan District, Balochistan. **Row 2, p1,** proximal right humeri GSP/MSM-195-4 of *Pakisaurus balochistani* showing posterior ridge and triceps fossa; **p2,3,** Comparison of left coracoid GSP/Sangiali-1112 of *Qaikshaheen masoomniazi* from mid Sangiali with left coracoid GSP/MSM-366-3 of *Pakisaurus balochistani* from Shalghara locality; **p4,5,** A braincase (GSP/MSM-2-16 and GSP-UM 7000) is being referred to *Gspsaurus pakistani* due to found associated with its Topkinwa assemblage; **p6,** best pictures of holotypic synsacrum articulated with pelvis (GSP-UM/Sangiali-1175) of *Imrankhanuqab qaeddiljani* [51] found from mid Sangiali locality (shown in Figure 4 of [51]), Vitakri dome area, Barkhan District, Balochistan Province, Pakistan. Scale, each black or white or yellow digit is 1 cm. Red scale bar is 5 cm.

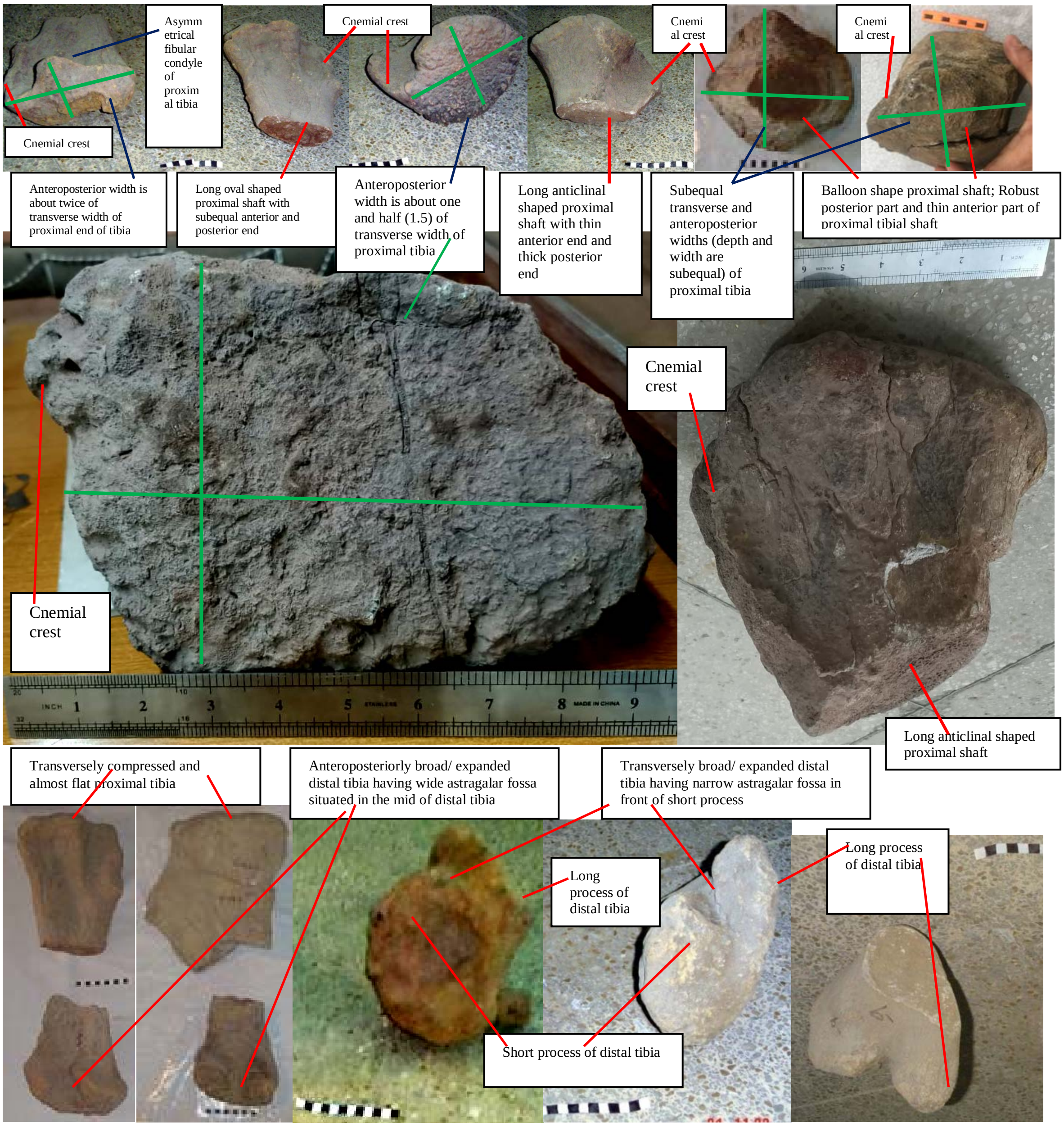

Figure 14. Row 1, p1,2, proximal right tibiae (proximal with upper shaft) GSP/MSM-72-2 from lower Bor of *Khanazeem saraikistani* in dorsal and lateroventral views; **p3,4,** proximal right tibiae (proximal with upper shaft) GSP/MSM-73-16 from Topkinwa of *Gspsaurus pakistani* in dorsal and lateroventral views; **p5,6,** proximal left tibiae (proximal with upper shaft) GSP/MSM-246-15 of *Balochisaurus malkani* from south Mari Bohri and GSP-UM/Sangiali-1120 of *Qaikshaheen masoomniazi* from mid-Sangiali in ventral views. **Row 2,** proximal left tibia with upper shaft GSP/MSM-181-2 of *Gspsaurus pakistani* from east Bor in dorsal and lateral views. **Row 3, p1,2,** anteroposteriorly broad subtriangular shaped distal tibiae GSP/MSM-186-2 of *Khanazeem saraikistani* from mid Bor and GSP/MSM-235-7 of *Imrankhanhero zilefatmi* from Zubra peak in lateral views; **p3**, transversely long subparalellogram or suboval shaped right distal tibia GSP/MSM-710-19 of *Gspsaurus pakistani* from Alam in ventral view; **p4,5**, transversely long subparalellogram or suboval shaped right distal tibia GSP/MSM-75-9 of *Balochisaurus malkani* from Grut in ventral and laterodorsal views. Scale, each black or white/yellow digit is 1 cm for row 1,3. Scale is in inches for row 2.

to adjust the large oval ungual for attachment or relevant phalange. A proximal and distal end is expanded with triangle shape. Metatarsals represent irregular concave proximal and distal expanded surface.

Table 2. Statistical data and information of Balochisauridae Poripuchian titanosaurs found from the latest Cretaceous (latest Maastrichtian) of Pakistan. The first appearance of the species name was not accompanied by proper diagnosis, designation of holotypic elements, or description (row 2 where mentioned). Those names remained *nomina nuda* until they were formally defined following rules of the International Code of Zoological Nomenclature (row 3). In some cases the locality name is followed by locality number among 25 Pakistan Dinosaur Localities (PDL-1 to PDL-25) ([70], pages 66, 68).These last four sentences also apply in Table 3 and Table 4.

Titles	*Balochisaurus malkani*	*Marisaurus jeffi*	*Qaikshaheen masoomniazi*
Informal Description	[55]	[55]	-
Formal Description	[64]	[64]	In present research
Holotype	Presacral vertebrae GSP/MSM-126-15 to GSP/MSM-130-15, GSP/MSM-822-15 to GSP/MSM-824-15, GSP/MSM-818-15; partial dorsal neural arch GSP/MSM-323-15; caudal vertebrae GSP/MSM-43-15, GSP/MSM-44-15, GSP/MSM-44a-15, GSP/MSM-45-15 to GSP/MSM-48-15, GSP/MSM-260-15, GSP/MSM-505-15, GSP/MSM-834-15,GSP/MSM-325-15; cervical rib GSP/MSM-881-15; caudal neural spine GSP/MSM-324-15; distal rib/neural spine GSP/MSM-672-15, GSP/MSM-1056-15; proximal dorsal rib GSP/MSM-322-15; dorsal rib GSP/MSM-531-15; left sternal plate GSP/MSM-675-15; left proximal humerus GSP/MSM-245-15; distal left humerus GSP/MSM-174-15; left proximal ulna GSP/MSM-78-15;proximal metacarpal GSP/MSM-297-15; distal metacarpal GSP/MSM-750-15; left acetabulum GSP/MSM-166-15; left proximal femur GSP/MSN-168-15; distal left femur GSP/MSM-173-15; proximal left tibia GSP/MSM-246-15; distal tibia/ulna? GSP/MSM-227-15.	Caudal vertebrae GSP/MSM-7-15, GSP/MSM-29-15 to GSP/MSM-33-15, GSP/MSM-815-15, GSP/MSM-808-15 and GSP/MSM-507-15; partial right proximal scapula GSP/MSM-163-15; partial proximal and distal pubis GSP/MSM-165-15, GSP/MSM-164-15;right femur (proximal GSP/MSM-169-15; and distal GSP/MSM-70-15) with many collected femoral cross sections which help to reconstruct full femur.	Partial posterior cervical centrum GSP-UM/Sangiali-1101, partial cervicodorsal centrum GSP-UM/Sangiali-1176, three partial dorsal vertebrae GSP-UM/Sangiali-1102, GSP-UM/Sangiali-1103, and GSP-UM/Sangiali-1123, dorsal neural arch GSP-UM/Sangiali-1104, three partial caudal vertebrae GSP-UM/Sangiali-1105, GSP-UM/Sangiali-1106, and GSP-UM/Sangiali-1107, distal scapula in 2 pieces GSP-UM/Sangiali-1108 and GSP-UM/Sangiali-1109, and mid scapula GSP-UM/Sangiali-1110; proximal left scapula GSP-UM/Sangiali-1111; left Coracoid GSP-UM/Sangiali-1112; proximal right humerus GSP-UM/Sangiali-1113; humerus cross section GSP-UM/Sangiali-1114; distal right humerus GSP-UM/Sangiali-1115; partial ischium GSP-UM/Sangiali-1116; proximal left femur GSP-UM /Sangiali-1118; right proximal and mid femur GSP-UM /Sangiali-1119; left distal femur GSP/MSM-1-1; left proximal tibia GSP-UM/Sangiali-1120; proximal left fibula GSP-UM/Sangiali-1121; mid left fibula GSP-UM/Sangiali-1122.
Holotypic elements	35	14	22
Type locality	Mari Bohri (latitude 29˚41'57"N; longitude 69˚14'59"E; Figure 4 of [51])	Mari Bohri (latitude 29˚42'08"N; longitude 69˚15'08"E; Figure 4 of [51])	Mid Sangiali (10 m long and 5 m wide area bounded by latitudes 29.69810N and 29.69812N and longitudes 69.39872E and 69.39882E) (Figure 4 of [51]).

Continued

Referred specimens	Caudal vertebrae GSP/MSM-52-9, GSP/MSM-793-9, 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. Proximal right femora GSP/MSM-749-15 and GSP/MSM-167-15, Left distal femur GSP/MSM-170-15 from Pakistan [51]. A mosaic type small sub oval armour bone (GSP/MSM-1095-17) from Dada Pahi 17 locality (Figure 1 of [64]). A distal neural spine MSM-5/02 Karkh (Figure 6, row 5 of [62]) (first Maastrichtian titanosaur bone from Kirthar basin/lower Indus basin).	Caudal vertebra GSP/MSM-40-8	Cervical vertebra GSP/MSM-359-2, cervicodorsal vertebra GSP/MSM-120-2, dorsal vertebrae GSP/MSM-121-2, GSP/MSM-122-2, GSP/MSM-123-2, GSP/MSM-124-2, GSP/MSM-125-2, GSP/MSM-441-2, a pair of sacral vertebrae GSP/MSM-135-2, caudal vertebrae GSP/MSM-41-2 and GSP/MSM-42-2, GSP/MSM-360-2, GSP/MSM-302-2, distal part of cervical rib GSP/MSM-187-2, distal thoracic rib GSP/MSM-301-2, neural spine GSP/MSM-792-2, distal rib/neural spine GSP/MSM-784-2, prezygapophyses and postzygapophyses GSP/MSM-560-2; parts of sternal GSP/MSM-565-2 and sternal part GSP/MSM-1004-2, a coracoid GSP/MSM-560-2, humerus parts GSP/MSM-559-2, GSP/MSM-287-2, GSP/MSM-363-2, GSP/MSM-362-2; left and right ulnae GSP/MSM-573-2 and GSP/MSM-271-2, distal ulna GSP/MSM-852-2; proximal metacarpals GSP/MSM-295-2,GSP/MSM-279-2, GSP/MSM-685-2, GSP/MSM-566-2, GSP/MSM-278-2, GSP/MSM-686-2, GSP/MSM-1029-2, GSP/MSM-688-2; distal metacarpals GSP/MSM-277-2, GSP/MSM-1028-2, GSP/MSM-285-2, GSP/MSM-370-2, GSP/MSM-684-2, GSP/MSM-687-2, GSP/MSM-361-2, GSP/MSM-683-2, proximal ischium GSP/MSM-184-2, a femur (proximal half GSP/MSM-178-2 and distal half GSP/MSM-182-2), and metatarsals GSP/MSM-643-2, GSP/MSM-1031-2 and GSP/MSM-1030-2 from Pakistan. A right humerus (Figure 2a, b, of Plate V [77]) from Bara Simla, India and a right humerus of 85cm length (GSI 20012, Figure 4 of Plate 1 of [78]) from Rahioli locality, Gujarat state, India were referred due to shape resembling with humerus GSP-UM/Sangiali-1113 (which is mistyped as GSP/Sangiali-1124 on page 1054 of [52]). A femur GSI/WR/M/90/84 from Rahioli locality [65] [78] [79] India referred due to same proportion and similarity with mid Sangiali femur (proximal GSP/Sangiali-1118 which was mistyped as GSP/Sangiali-13 on page 1054 of [52], and distal femur GSP/MSM-1-1) from Pakistan.
Referred Elements	11	1	50 (+49 Miscellaneous pieces from Sangiali)
Referred localities	Grut 9 (Figure 1 of [64]), Dada Pahi (Figure 4 of [51] and Mari Bohri 15 (Figure 4 of [11] from Pakistan.	Darwaza (Figure 1 of [64])	Mid Bor (Figure 4 of [51]) from Pakistan. Rahioli locality of Gujarat and Bara Simla locality of Jabalpur India.

Continued

Total holotypic and referral elements	46	14 + 1 = 15	72 (+49 miscellaneous pieces)
Total Individuals	4	2	4
Horizon/Formation	Vitakri Formation	Vitakri Formation	Vitakri Formation; Lameta Formation
Age	Latest Maastrichtian	Latest Maastrichtian	Latest Maastrichtian
Distribution Territory; (Basin) wise	Barkhan District, Balochistan Province; (middle Indus/Sulaiman basin). Kirthar basin/lower Indus basin.	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin)	Barkhan District, Balochistan Province; (Sulaiman foldbelt/lower Indus basin). Rahioli, Gujarat, western India and Bara Simla, Jabalpur, central India.

Table 3. Statistical data and basic information of Gspsauridae (Poripuchia) titanosaurian sauropods found from the latest Cretaceous Vitakri Formation of Pakistan. **Maojandino alami* has same 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 consider only two 2 cranial specimens GSP/MSM-79-19 and GSP/MSM-80-19 as a whole holotype of *Gspsaurus pakistani*.

Titles	*Gspsaurus pakistani*	*Maojandino alami*	*Saraikimasoom vitakri*	*Nicksaurus razashahi*	*Ikqaumishan smqureshi*
Informal Description	[59]	[60] [61]	[59]	[59] [60]	-
Formal Description	[51]	[64]	[51]	[64]	In present research
Holotype	Two associated cranial fragments including a partial dentary ramus, quadrate, and quadratojugal (GSP/MSM-79-19) and 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; caudal vertebrae GSP/MSM-113-19, GSP/MSM-114-19, GSP/MSM-115-19, GSP/MSM-116-19, GSP/MSM-117-19, GSP/MSM-218-19, GSP/MSM-219-19, GSP/MSM-221-19, GSP/MSM-696-19, GSP/MSM-777-19; vertebral fragment GSP/MSM-146-19; left and right partial distal scapula GSP/MSM-1100-19, GSP/MSM-217-19; proximal radius GSP/MSM-215-19; partial	*Same as *Gspsaurus pakistani* except the cranial specimen (GSP/MSM-79-19 and GSP/MSM-80-19).	Snout GSP/MSM-142-4, consisting of articulated left and right premaxillae, left and right maxillae, dorsal and ventral palatal process, left and right dentary, and complete teeth row.	Jaw ramus with 6 teeth GSP/MSM-138-4n; cranial materials and teeth fragments in matrix GSP/MSM-315-4n and GSP/MSM-314-4n; cervical vertebrae GSP/MSM-381-4n to GSP/MSM-383-4n; cervical/dorsal vertebra GSP/MSM-212-4n; caudal vertebrae GSP/MSM-347-4n, GSP/MSM-348-4n;caudal chevron GSP/MSM-313-4n;	A partial proximal and mid humerus GSP-UM/Sangiali-1125.

Continued

	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			humerus fragments GSP/MSM-380-4n, GSP/MSM-377-4n, GSP/MSM-379-4n, GSP/MSM-438-4n; proximal radius GSP/MSM-344-4n; proximal pubis GSP/MSM-1096-4n; left femur GSP/MSM-190-4n; right distal femur GSP/MSM-192-4n; right femur fragments GSP/MSM-378-4n, GSP/MSM-270-4n; left and right distal tibiae GSP/MSM-346-4n, GSP/MSM-345-4n	
Holotypic elements	33	31*	1	22	1
Type locality	Alam (central Alam) (latitude 29˚41'0.7"N; longitude 69˚23'58"E; Figure 4 of [51])	*central Alam	South Kinwa* (latitude 29˚40'57"N; longitude 69˚23'09"E; Figure 4 of [51])	North Kinwa (latitude 29˚41'16"N; longitude 69˚23'31"E; Figure 4 of [51])	Upper Sangiali or South Sangiali (Figure 4 of [51]) latitude 29.69809N and longitude 69.39882E.
Referred specimens	A braincase (GSP/MSM-2-16 and GSP-UM 7000), a pair of coossified sacral vertebrae GSP/MSM-137-16, dorsal vertebrae GSP/MSM-131-16 and GSP/MSM-132-16, caudal vertebrae GSP/MSM-34-16 and GSP/MSM-35-16, distal caudal vertebra GSP/MSM-153-16, a pair of left and right distal scapulae GSP/MSM-250-16 and GSP/MSM-176-16, a pair of left and right proximal ulna GSP/MSM-175-16 and GSP/MSM-240-16, distal ulna GSP/MSM-74-16, distal radius GSP/MSM-160-16, 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	*Same as *Gspsaurus pakistani*	-	caudal vertebrae GSP/MSM-523-7 and GSP/MSM-524-7, scapula GSP/MSM-746-7 and osteoderm GSP/MSM-84-7	Proximal humerus GSP/MSM-237-10 from Rahi Wali (Figure 1 of [64]. Some vertebrae and limb bones from upper Sangiali locality (Figure 4 of [51] of Pakistan observed in the field and not collected due to avoid repetitions. Referred right

Continued

	GSP/MSM-1014-16, sternal part GSP/MSM-604-16, part of ilia GSP/MSM-557-16, part of ilia or spine with glenoid or wound mark GSP/MSM-150-16, vertebral process/distal rib/distal spine/metatarsal/metacarpal GSP/MSM-391-16, distal cervical ribs GSP/MSM-328-16, GSP/MSM-329-16, distal cervical rib GSP/MSM-767-16, mosaic type osteoderm GSP/MSM-83-16, mosaic type osteoderm GSP/MSM-1035-16, and osteoderm or platy oval ungual or sacral vertebrae GSP/MSM-776-16 from Top Kinwa. Vertebral arch GSP/MSM-82-4, associated caudal vertebrae GSP/MSM-36-4, 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 distal 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 with associated proximal shaft GSP/MSM-850-2 from east Bor, Pakistan [62] [64]. A caudal vertebra K20/317 and a humerus from Bara Simla India and right and left humeri from Chhota Simla limb skeleton from India [62] [64].				and left humeri (78cm length) GSI type no 20010 (Figures 1a, b, of Plate 1 of [78]) and GSI 20011 [78] reported from Rahioli locality, Gujarat state, India are being referred.
Referred Elements	41 elements from Pakistan; 8 elements from India	*Same as *Gspsaurus*	-	4	+3
Referred localities	Top Kinwa 16, east Bor 2 and South Kinwa 4 (Figure 4 of [51]) from Pakistan. Chhota Simla and Bara Simla localities of Jabalpur, central India and Rahioli locality of Gujarat state of western India.	*Same as *Gspsaurus*	-	South Zubra; Figure 1 of [64].	Rahi Wali (Rahiwali) (Figure 1 of [64) Pakistan. Rahioli, India.
Total holotypic and referral elements	82	*80	1	26	+4
Total Individuals	6	*6	1	2	3
Horizon/ Formation	Vitakri Formation; Lameta Formation	Vitakri Formation; Lameta Formation	Vitakri Formation	Vitakri Formation	Vitakri Formation. Lameta Formation

Continued

Age	Latest Maastrichtian	Latest Maastrichtian	Latest Maastrichtian	Latest Maastrichtian	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 Basin, Pakistan)	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin, Pakistan)	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin) (Pakistan). Rahioli, Gujarat (western India)

Table 4. Statistical data/information of Pakisauridae Poripuchian titanosaurs from Pakistan.

Titles	*Khanazeem saraikistani*	*Pakisaurus balochistani*	*Sulaimanisaurus gingerichi*	*Khetranisaurus barkhani*	*Imrankhanhero zilefatmi*
Informal Description	-	[55]	[55]	[55]	-
Formal Description	[52]	[51]	[51]	[51]	In present research
Holotype	Dentary ramus and teeth GSP/MSM-143-2; caudal vertebrae GSP/MSM-16-2, GSP/MSM-793-2; left proximal and mid femur GSP/MSM-69-2;right femur including proximal GSP/MSM-294-2,mid-GSP/MSM-293-2, and distal sections GSP/MSM-266-2;partial humerus GSP/MSM-289-2; distal humerus GSP/MSM-180-2; proximal humerus GSP/MSM-288-2, mid humerus GSP/MSM-290-2; partial right tibia GSP/MSM-72-2; distal tibia GSP/MSM-186-2; proximal and mid left tibia GSP/GSP/MSM-286-2	Presacral vertebrae GSP/MSM-340-4, GSP/MSM-341-4, GSP/MSM-342-4, GSP/MSM-376-4, GSP/MSM-517-4, GSP/MSM-800-4, GSP/MSM-809-4,GSP/MSM-810-4 and GSP/MSM-1011-4; cervicodorsal vertebra GSP/MSM-133-4;partial sacrumGSPMSM-136-4; GSP/MSM-1008-4; caudal vertebrae GSP/MSM-11-4, GSP/MSM-12-4,GSP/MSM-13-4, GSP/MSM-14-4, GSP/MSM-207-4, GSP/MSM-763-4, GSP/MSM-1010-4; neural spine GSP/MSM-601-4; partial neural arches GSP/MSM-878-4, GSP/MSM-804-4, GSP/MSM-805-4,fragments pertaining to right and left scapulae (GSP/MSM-878a-4; GSP/MSM-318-4 and GSP/MSM-319-4; GSP/MSM-201-4; GSP/MSM-590-4; GSP/MSM-593-4; GSP/MSM-203-4; GSP/MSM-205-4; GSP/MSM-162-4); partial sternal plates GSP/MSM-355-4, GSP/MSM-598-4; proximal right	Caudal vertebrae GSP/MSM-17(a)-4, GSP/MSM-18-4, GSP/MSM-19-4, GSP/MSM-20-4, GSP/MSM-21-4, GSP/MSM-21(a)-4, GSP/MSM-22-4	Caudal vertebrae GSP/MSM-27-4, GSP/MSM-28-4	A partial right proximal and mid humerus GSP-UM/Sangiali-1124, distal humerus GSP/MSM-262-1, distal right femur GSP/MSM-232-1 and proximal right fibula GSP-UM/Sangiali-1117.

Continued

		humerus GSP/MSM-202-4; humerus parts GSP/MSM-268-4, GSP/MSM-210-4 and GSP/MSM-210a-4; distal humerus GSP/MSM-193-4; distal radius GSP/MSM-159-4; a pair of proximal ulnae-left and right proximal ulnae GSP/MSM-603-4,GSP/MSM-600-4;shaft of proximal ulna GSP/MSM-211-4, GSP/MSM-678-4; partial metacarpals GSP/MSM-280-4, GSP/MSM-970-4; partial ilium GSP/MSM-971-4, GSP/MSM-972-4, GSP/MSM-594-4, GSP/MSM-806-4;right proximal femur GSP/MSM-595-4 and distal right femur GSP/MSM-200-4;proximal right fibula GSP/MSM-349-4; distal fibula GSP/MSM-580-4; proximal left fibula GSP/MSM-384-4; and partial metatarsal GSP/MSM-350-4			
Holotypic elements	14	56	7	2	4
Type locality	Lower Bor Latitude 29.68700 and Longitude 69.3771 (N 29˚41'12" and E 69˚22'37") (Figure 4 of [51])	South Kinwa (Southwestern Kinwa) 29˚41'05"N and 69˚23'05"E (south of foot track) including vertebrae and other bones), and at 29˚41'06"N and 69˚23'05"E (north of foot track) including complete diagnostic humerus and other bones) (Figure 4 of [51])	South Kinwa (Southernmost Kinwa) (latitude 29˚40'54"N; longitude 69˚23'04"E) (Figure 4 of [51])	Mid Kinwa (latitude 29˚41'04"N; longitude 69˚23'17"E) (Figure 4 of [51])	Lower Sangiali or north Sangiali (Figure 4 of [51]) latitude 29.69812N and longitude 69.39860E.
Referred specimens	Caudal vertebrae GSP/MSM-17-16, GSP/MSM-510-16 and GSP/MSM-154-16; prezygapophyses GSP/MSM-327-16; caudal chevron GSP/MSM-330-16 in 2, proximal ulna GSP/MSM-1032-16 from Pakistan. A femur from Rahioli, western India (ISI 622-623-624; Bandyopadhyay, pers. communication with Jeffrey A. Wilson; [65])	Proximal pubis GSP/MSM-403-19n, proximal radius GSP/MSM-756-19n; distal ulna GSP/MSM-628-19n and caudal vertebra GSP/MSM-758-19n; fractured distal caudal vertebra GSP/MSM-523-3, distal caudal vertebra with horizontal groove on posterior cone GSP/MSM-151-3, Coracoid GSP/MSM-366-3, ulna GSP/MSM-748-3, ungula GSP/MSM-152-3, and spongy thick armour spine GSP/MSM-150-3: proximal rib GSP/MSM-321-13; proximal right humerus GSP/MSM-195-4; caudal vertebra	Caudal vertebrae GSP/MSM-24-15, GSP/MSM-25-15 and GSP/MSM-26-15; caudal vertebra GSP/MSM-23-3 from Pakistan.	One vertebra like holotype was found on mid Kinwa (just west of foot track) and other bones (mostly caudal vertebrae and limb bones).	Flattened tibia GSP/MSM-235-7, fibula GSP/MSM-253-7 and metatarsal GSP/MSM-296-7 from Zubra peak, Pakistan. Further referred tibia K 20/321 (Figures 4a, b, of Plate 1 of [77]) and right fibula K 27/489 (Figures 5a, b, of Plate 1 of [77]) from

Continued

	also possesses the slender proportions, proximolateral profile and inflected head present in lower Bor left and right femora [52].	GSP/MSM-15-15 from Pakistan. Right and left humeri of 70cm length from Rahioli Gujarat India area (GSI type no 20008, Plate 1, Figure 3 of [78]; GSI 20009; Plate 1, Figure 2 of [78]) were referred from India due to shape with features resembling [52].			Bara Simla, India [77] are being referred to *Imrankhanhero zilefatmi* due to shape resembling with its South Zubra exemplar's tibia and fibula (see detail in text).
Referred Elements	6	15	4	-	5
Referred localities	Top Kinwa 16 (Figure 4 of [51]) from Pakistan [52], and Rahioli, Gujarat, western India [52].	North Alam 19, Shalghara 3, South Kinwa 4s, East Dolwahi 13, Mari Bohri 15 (Figure 4 of [51];Figure 1 of [64]) from Pakistan, and Rahioli Gujarat, western India [52].	Mari Bohri 15 and Shalghara 3 (Figure 4 of [51]; Figure 1 of [64]) from Pakistan.	Mid Kinwa 4 or 4m (Figure 4 of [51])	Zubra peak 7 (Figure 1 of [64]) (latitude 29˚43'12"N; longitude 69˚30'16"E) from Pakistan. Bara Simla from India.
Total holotypic and referral elements	14+6=20	56+15=71	7+4=11	2	9
Total Individuals	3	6	3	1	3
Horizon/Formation	Vitakri Formation; Lameta Formation	Vitakri Formation; Lameta Formation	Vitakri Formation	Vitakri Formation	Vitakri Formation Lameta Formation
Age	Latest Maastrichtian	Latest Maastrichtian	Latest Maastrichtian	Latest Maastrichtian	Latest Maastrichtian
Distribution Territory; (Basin) wise	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin). Rahioli, western India	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin). Rahioli western India	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin).	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin)	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin). Bara Simla, central India.

3.3.3. New Titanosaurian Sauropod *Ikqaumishan smqureshi* from the Latest Maastrichtian Vitakri Formation of Pakistan

Systematic Paleontology

Dinosauria; Saurischia; Sauropoda; Titanosauriformes; Titanosauria; Poripuchia [58] vide [51]; Gspsauridae [61] vide [51]; Gspsaurinae [61] vide [51];

Ikqaumishan smqureshi new genus and new species (**Figure 13**).

Holotype: A diagnostic partial humerus (GSP-UM/Sangiali-1125) (**Figure 13**) is designated as holotype. This holotypic humerus found as 3 pieces but fit into an almost complete proximal and mid humerus GSP-UM/Sangiali-1125 (**Figure 13**), so belong to a single individual. Fossil is housed in museum of Geological Survey of Pakistan, Quetta, Pakistan but now present at the Museum of Paleontology, University of Michigan, USA and will return back to its original position in the museum of Geological Survey of Pakistan, Quetta, Pakistan. Further from upper Sangiali (south Sangiali) locality, a few ventrally reduced caudal vertebrae, and limb fossils (page 68 of [70]) were found in Vitakri Formation. After the collection of about 2800 bones, the bone assemblages and many bones were observed and left in site for future study, but not collected during later field visits. These observations are mentioned in 2009 by reference (page 68 of [70]) and in many other reports. This is also discussed (see above). During collection of mid sangiali assemblage, a few bones were found and collected in the vicinity of mid Sangiali. Holotypic humerus of *Ikqaumishan smqureshi* seems to be taken from upstream area (just above the mid Sangiali). In this way a holotypic proximal humerus of *Ikqaumishan smqureshi* was considered from South Sangiali/upper Sangiali. Further among mid Sangiali collections, a few bones were in duplication and their size will not match. One simple armor plate (GSP/MSM-8-1; GSP-BC-001/01) from southern bank of Sangiali stream of titanosaur (and two crocodilian specimens GSP/MSM-9-1 (GSP-BC-002/01) and GSP/MSM-10-3 (GSP-BC-003/01) from Shalghara, see below) were received by Dr David Krauss, Bostan College, USA (during his field visit in 2001) from Geological Survey of Pakistan for preparation ([66], pages 532-534; [99], page 245). This simple armor plate GSP/MSM-8-1 (GSP-BC-001/01) found from southern bank of Sangiali stream of Sangiali dinosaur locality, may belong to a same and single individual of holotypic humerus (see detail below).

Type locality, horizon and age: Holotype was found in the upper Sangiali locality (Pakistan dinosaur locality 1; shown in Figure 4 of [51]) at latitude 29.69809N and longitude 69.39882E of Vitakri dome area, Barkhan district, Balochistan Province, Pakistan. This holotype is found just above/south of the mid Sangiali locality shown in Figure 4 of [51], the area just above/south of mid Sangiali in mapped triangle (Figure 4 of [51]) is included in south Sangiali/upper Sangiali. Host horizon of holotype is the upper varicolored but dominantly maroon mud caped by upper sandstone unit of Vitakri Formation (Table 1 of [52]) of Fort Munro Group [21] [22] [70]. According to stratigraphic position and previously well dated Maastrichtian Pab Formation (lower formation) and well dated Paleocene formations (upper formations), the age of Vitakri Formation considered latest Maastrichtian ([27] pages 904-905, [49] [50] [51] [58] [89]). For detail please see above. Further referred right and left humeri (78 cm length) GSI type no 20010 (Figure 1(a), Figure 1(b) of Plate 1 of [78]) and GSI 20011 [78] from Rahioli locality of Gujarat state, India reported from the latest Maastrichtian Lameta Formation.

Referred specimens: A proximal right humerus GSP/MSM-237-10 from Rahi Wali locality (Figure 1 of [64]) of Mazara-Dhaola-Andari Range of Pakistan is being referred to *Ikqaumishan smqureshi* based on shape resembling and posterior plain surface just below the head. Further right and left humeri (78 cm length) GSI type no 20010 (Figure 1(a), Figure 1(b) of Plate 1 of [78]) and GSI 20011 [78] reported from Rahioli locality, Gujarat state, India from Lameta Formation are being referred to *Ikqaumishan smqureshi* based on shape resembling and also matching features medially inset, slender and almost straight deltopectoral crest and posterior smooth surface just below head. The referred humeri from India provide additional informations especially about distal humeri.

Etymology: The genus name *Ikqaumishan* honors the Former Prime Minister Imran Khan and great journalist Imran Khan (both abbreviated as I.K.) to support poor peoples of Sulaiman Basin of Pakistan which is the host of these fossils, and *qaumi*, Urdu/Saraiki for nation, and *shan*, Urdu/Saraiki for respect. The genus name *Ikqaumishan* can be pronunciated as I.K.-Qaumi-Shan. The species name *Ikqaumishan smqureshi* honors the honorable Shah Mahmood (Qureshi) and Saeed Murad (Murad Saeed) (abbreviated as *sm,* for both) formers federal ministers of Pakistan, *qureshi* for tribe name of Mohtram Shah Mahmood Qureshi for his support to the Saraiki, Balochi and other poor peoples of Koh Sulaiman Range and Sulaiman foldbelt of Pakistan (host of fossils). The species name *Ikqaumishan smqureshi* can be pronunciated as S.M. Qureshi.

Diagnosis: *Ikqaumishan smqureshi* medium sized sauropod shares with the Titanosauria on the basis of procoelous caudal vertebrae which are found from this upper Sangiali (south Sangiali) locality. It shares with Poripuchia because of sharing with Gspsauridae. It shares with Gspsauridae on the basis of medially inset and almost straight deltopectoral crest. Its autapomorphy shown as; *Ikqaumishan smqureshi* has medially inset, slender and almost straight deltopectoral crest and strong medial expansion of medial process of proximal humerus (**Figure 13**), while this prominent medially expanded medial process is not found in any Indo-Pakistani titanosaurs. Its deltopectoral crest is more slender (and straight) than the slender deltopectoral crest of *Gspsaurus pakistani*, intermediate (between slender and robust) and sinusoidal deltopectoral crest of *Imrankhanhero zilefatmi* (and may be *Isisaurus colberti*) and robust deltopectoral crest of *Qaikshaheen masoomniazi* and *Pakisaurus balochistani*. Its deltopectoral crest is relatively thin at the base/ventral portion than the deltopectoral crest of *Gspsaurus pakistani* specimen NHMUK R5931 from Chhota Simla ([51], page 289; [52], page 1045; ([27], see Table 3; [62], page 459) which are more thick and sub-circular shaped peak forming. Its humerus has posteriorly plain surface while *Pakisaurus balochistani* has posterior ridge just below the head with triceps fossae. Further diagnosis and comparison are described as below.

Description of elements

Caudal vertebrae: A few caudal vertebrae found in the south Sangiali (upper

Sangiali) are procoelous, and show ventral reduction. Its caudal centrum is heavy like those of Balochisaurids and Gspsaurids, while Pakisaurids have relatively light and ventrally not reduced. Its caudal centrum is ventrally reduced and more heavy than those of *Imrankhanhero zilefatmi*.

Humerus: A holotypic partial right humerus (proximal and mid portion GSP-UM/Sangiali-1125) (**Figure 13**) collected from upper Sangiali (possibly just above the mid Sangiali). A partial humerus GSP/MSM-237-10 from Rahi Wali (**Figure 13**) is referred to *Ikqaumishan smqureshi* on the shape resembling and matching of posterior plain surface just below the head and shaft cross section just below the deltopectoral crest. This referred humerus is providing more significant features which portion is not preserved in holotype. Further right and left humeri (78cm length) GSI type no 20010 (Figure 1(a), Figure 1(b) of Plate 1 of [78]) and GSI 20011 [78] reported from Rahioli locality, Gujarat state, India are being referred to *Ikqaumishan smqureshi* based on matching features medially inset, slender, relatively thin and almost straight deltopectoral crest and also posterior smooth surface just below the head.

Ikqaumishan smqureshi has relatively slender and distinguished deltopectoral crest and expansion of medial process of proximal humerus which are not shown in any Indo-Pakistani titanosaurs (as shown above). *Ikqaumishan smqureshi* has medially inset, slender and almost straight deltopectoral crest and medially prominent expanded medial process of proximal humerus (**Figure 13**) and posterior plain surface just below the head (**Figure 13**), 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, *Balochisaurus malkani* has smooth posterior plain just below the head and relative more downward migrated head, *Imrankhanhero zilefatmi* has medially inset, intermediate (between slender and robust) and sinusoidal deltopectoral crest, and *Isisaurus colberti* has medially inset and relatively robust deltopectoral crest. The Rahiwali humerus (**Figure 13**) of *Ikqaumishan smqureshi* has prominent medial expansion than other humeri of *Qaikshaheen masoomniazi*, *Imrankhanhero zilefatmi* and *Pakisaurus balochistani*, *Gspsaurus pakistani* and *Isisaurus colberti*. The shaft section just below the deltopectoral crest shows that mediolateral width is slightly more than anteroposterior depth. The distal humerus show posterior concavity for the adjustment of olecranon process of ulna and anteriorly expanded radial condyle known from Rahioli referred humeri. The posterior incline thin ridges on holotypic humerus of *Ikqaumishan smqureshi* has no medial and lateral triceps fossae and may be due to diagenetic and or tectonic compression.

Six morphs of humeri from Indo-Pakistan appeared on comparison of the humerus of *Ikqaumishan smqureshi* with other humeri of different genera. The first morph is represented by medially inset deltopectoral crest and posterior ridge just below the head and continue to midshaft flanked by lateral triceps fossa and medial triceps fossa with exemplar as *Pakisaurus balochistani* (row 2 of **Figure 13**) from Pakistan and also from India [52] [78] and adult and juvenile *Diamantinasaurus matildae* from Australia [93] [94] [95] and *Rapetosaurus krausei* from Madagascar [98]. Triceps fossa is site for attachment of tridirectional movement muscles. The finding of this morph of humeri from Indo-Pakistan (South Asia) and also from Australia and Madagascar show their land associations. The second morph is represented by medially inset slender deltopectoral crest and posterior smooth plain surface just below the head, and prominent medial expansion of medial process of proximal humerus (**Figure 13**) with exemplar *Ikqaumishan smqureshi*. The third morph is represented by medially inset, intermediate (between slender and robust) deltopectoral crest and posterior smooth plain surface just below the head (**Figure 13**) with exemplar *Imrankhanhero zilefatmi*. The fourth morph is represented by medially inset, subcircular ridge at the ventral base and straight deltopectoral crest and posterior smooth plain surface just below the head, and relatively less (than *Ikqaumishan smqureshi* humerus) medial expansion of medial process of proximal humerus with exemplar *Gspsaurus pakistani* from Indo-Pakistan subcontinent, and *Atsinganosaurus velauciensis* from France [99]. The fifth morph is represented by relatively laterally set robust deltopectoral crest and posterior smooth plain surface just below the head (**Figure 11**) with exemplar *Qaikshaheen masoomniazi*. The sixth morph is represented by downward migrated head of proximal humerus, and plain surface just below the head and anteriorly expanded relatively large radial condyle flushed with lateral condyle (**Figure 7**, row 5 of [64]; Figure 7, rows 1, 2 of [63]) with exemplar *Balochisaurus malkani*. Further variation in distal humeri was also discussed (see above).

Limb bones: Limb bones along with ventrally reduced caudal vertebrae [70] were found in the upper Sangiali (south Sangiali) suggesting their assignment to stocky titanosaurian sauropods.

Osteoderm: One simple armor plate or osteoderm GSP/MSM-8-1 (GSP-BC-001/01) of titanosaur (found from southern bank of Sangiali stream) was received by Dr David Krauss, Bostan College, USA (during his field visit in 2001) from Geological Survey of Pakistan for preparation ([66], pages 532-534), along with the following crocodile fossils (see below). This armor plate of titanosaur was collected from the southern Bank of Sangiali stream. Further this armor plate site located in the south of mid Sangiali assemblage. The catchment area of this armor plate which is found on the southern bank of stream represents southern Sangiali. So it is found very close to holotypic humerus GSP-UM/ Sangiali-1125 of *Ikqaumishan smqureshi*. So it is possible it may be belong to single individual of the holotypic humerus. This armor bone is thin and subcircular and without internal duct. *Ikqaumishan smqureshi* armor bone is simple, small and thin subcircular plate without internal duct, while *Gspsaurus pakistani* has slightly more thick and subrectangular mosaic armor plates (GSP/MSM-83-16 and GSP/MSM-1035-16) (**Figure 5** of [62]) from Topkinwa which bears many irregular internal ducts, *Gspsaurus pakistani* has large, thick and heavy ellipsoidal plate (GSP/MSM-85-4) with median groove found from south Kinwa (**Figure 7** of [62]), *Nicksaurus razashahi* has large, thick and heavy ellipsoidal plate without median groove/cut (GSP/MSM-84-7) found from south Zubra (**Figure 9** of [63]), and *Balochisaurus malkani* has the mosaic type small sub oval armour bone (GSP/MSM-1095-17) (**Figure 9** of [63]) from Dada Pahi 17 locality. The large and heavy ellipsoidal osteodermal plate (GSP/MSM-84-7) of *Nicksaurus razashahi* resemble with *Malawisaurus* [100] of Malawi, Africa. The large and heavy ellipsoidal plate (GSP/MSM-85-4) of *Gspsaurus pakistani* resemble with titanosaur (plate 77 of [85]) from Argentina, South America. These large heavy ellipsoidal osteoderms show paleobiogeographic link with Africa and South America of Gondwana. In this way majority of bones show affinity to Gondwana and while some also show affinity to Laurasia.

Paleobiogeographic Implications

Here first I described the useful feedback on fossils of Shalghara locality and their paleobiogeographic affinity and then other significant key elements of titanosaurian sauropods from Pakistan with paleobiogeographic implications. Only one crocodile *Mithasaraikistan ikniazi* [51] and one theropod *Shansaraiki insafi* [52] were named from Shalghara locality 3 (Pakistan dinosaur locality no. 3) with Latitude 29.68288 and Longitude 69.38008 (N 29˚40'58"; E 69˚22'48") (as shown in Figure 4 of [51]) of Vitakri dome area, Barkhan district, Balochistan. *Mithasaraikistan ikniazi* [51] based on Snout GSP/MSM-4-3 and dentary ramus GSP/MSM-139-3. Further a partial humerus GSP/MSM-9-3 (GSP-BC-002/01) and three articulated vertebrae GSP/MSM-10-3 (GSP-BC-003/01) of crocodiles (see below) found from Shalghara locality are being referred to *Mithasaraikistan ikniazi* on the basis of finding from one Shalghara locality, more holotypic elements (than single referred dentary symphysis of *Pabwehshi Pakistanensis* from Shalghara [67]) and also size agreement. *Mithasaraikistan ikniazi* [51] is diagnosed on the strongly medially inset of premaxillary teeth, while *Pabwehshi pakistanensis* has relatively laterally flushed premaxillary teeth. One simple armor plate GSP/MSM-8-1 (GSP-BC-001/01) of titanosaur found from southern bank of Sangiali stream, a partial humerus GSP/MSM-9-3 (GSP-BC-002/01) and three articulated vertebrae GSP/MSM-10-3 (GSP-BC-003/01) of crocodiles found from Shalghara locality were received by Dr David Krauss, Bostan College, USA (during his field visit in 2001) from Geological Survey of Pakistan for preparation in 2001 ([66], pages 532-534; [101], page 245).

Shansaraiki insafi was based on specimens GSP/MSM-140-3 (symphysis), GSP/MSM-5-3 (mid ramus with partial teeth bases) and GSP/MSM-57-3 (dorsal vertebra) that were found from the Shalghara locality 3 with Latitude 29.68288 and Longitude 69.38008 (N 29˚40'58"; E 69˚22'48") (as shown in Figure 4 of [52]) of Vitakri dome area, Barkhan district, Balochistan. The number following the locality such as Shalghara 3 or Shalghara locality 3 and last number of most of specimen numbers represents the locality number of Pakistan Dinosaur Localities PDL-1 to PDL-25. The following two feedbacks and positive criticism were provided regarding *Shansaraiki*. The Prehistoric Wiki entered the *Shansaraiki insafi* on web is encouraging, but mentioned that the *Shansaraiki* "named from GSP/MSM-140-3 (symphysis), GSP/MSM-5-3 (mid ramus with partial teeth bases) and GSP/MSM-57-3 (dorsal vertebra) that were found from various areas within the Vitakri dome. Doubt about these remains connectiveness and validity has been raised, since they were found apart and are extremely fragmentary" (*Shansaraiki* in prehistoric.wiki.fandom.com). On designing the type locality of *Shansaraiki* ([52], page 1067), it is clearly mentioned the Shalghara locality 3 of Vitakri Dome area with one site grid coordinates. They may be confused from Shalghara locality 3, here 3 represents Pakistan Dinosaur Locality 3 (among PDL-1 to PDL-25; pages 66 and 68 of [52]). It is also cleared in caption of Figure 2 of ([52], page 1046). Further Shalghara locality has only one site from where the fossils were collected and reported. It is no doubt these fossils were found surface find fragmentary from only one site of Shalghara Locality but not from different areas of Vitakri dome. Vitakri dome has more than 10 kilometer area (5*2km area; see in Figure 2 of [70]) which hosts many localities and also many type localities and many sites within a locality at places. So it is expected the Prehistoric Wiki will correct this fact to avoid any ambiguity. The Tyler Greenfield on twitter questioned regarding *Shansaraiki* holotype and diagnosis "Why are a dentary symphysis and dorsal vertebrae that were not found together referred to the same taxon? Why were they named at all when they have no diagnostic features? (December 5, 2022 on twitter by @Tyler Greenfield). The reply of his first question is found in Holotype title ([52], page 1067). Holotypic bones found as fragmentary on the surface of same Formation, same locality, same time, fit size and no duplication shows associated bones of single individual ([52], page 1067). He may also be confused from Shalghara locality 3, here 3 represents Pakistan Dinosaur Locality 3. It is cleared in caption of Figure 2 of ([52], page 1046). Further it is necessary to mention that the dentary symphysis and dorsal vertebrae are not found together in animal but they were located apart and have some distance between them. The reply of his second question is found in diagnosis and comparison ([52], pages 1069-1072). From Indo-Pakistan this theropod is unique (see diagnosis and comparison in pages 1069-1072 of [52]). The dentary ramus of *Shansaraiki insafi* does not bear lateral step while *Rajasaurus narmadensis* [102] represent lateral step on dentary ramus. Further its dentary and its anterior weak symphysis matches closely with dentary of *Australovenator wintonensis* from Australia [93]. The suggestions regarding third question is to go through in detail study of more recent research on Pakistani dinosaur taxa (3 theropods and 13 titanosaurian sauropods), although proliferated but most of these are diagnostic. These both feedbacks are very positive and useful for our understandings of Pakistani dinosaurs.

From Pakistan many diverse and significant fossils for taxonomy and paleobiogeographic implications were found from the latest Maastrichtian Vitakri Formation. The nature of V-shaped teeth arcade of *Gspsaurus pakistani* and 40^0 anterior slope of cranial face of *Saraikimasoom vitakri* poripuchian titanosaur are endemic in Titanosaurs especially in derived titanosaurs. The procoelous tail vertebrae are common while the *Balochisaurus malkani* and *Marisaurus jeffi* have first biconvex caudals like those of *Pellegrinisaurus* and *Neuquensaurus* from Argentina, South America, and *Alamosaurus* from USA, North America [62] [63] [103]. This feature revealed the Paleobiogeographic link of Indo-Pakistan subcontinent with both Gondwana (southern lands) and Laurasia (northern lands). This feature and element shows worldwide distribution. The *Khanazeem saraikistani* has unique and endemic slender femur with inflected head and a lateral concavity between the proximolateral corner of head and lateral bulge.

The *Pakisaurus balochistani* is diagnostic on two major key elements and their features as inflected head of femur and posterior ridge (**Figure 13**) just below the head of humerus along with lateral and media triceps fossae [27] [52]. This humeral key element of *Pakisaurus balochistani* Pakistani titanosaur ([27] and references therein) closely resemble with mid Cretaceous and late Cretaceous Australian titanosaur *Diamantinasaurus matildae* [94] [95] and late Cretaceous Malagasy (Madagascar) *Rapetosaurus krausei* [98].

The most robust tibiae of *Balochisaurus malkani* ([27] and references therein) and *Qaikshaheen masoomniazi* (**Figure 11**) shows extreme transverse expansion resulting subequal transverse and anteroposterior widths of proximal tibia (**Figure 14**), resemble closely with *Lohuecotitan pandafilandi* [91] from upper Cretaceous of Spain (Europe), *Lusotitan atalaiensis* [92] from late Jurassic of Portugal (Europe), *Diamantinasaurus matildae* [93] [94] from mid Cretaceous of Australia and *Janenschia robusta* [104] from the late Jurassic of Tanzania (Africa).

The robust tibiae of *Gspsaurus pakistani* has intermediately transverse expanded proximal tibia with anteroposterior width which is 1.5 of transverse width like those of *Atsinganosaurus velauciensis* titanosaur from the upper Cretaceous of southern France [99] and *Mendozasaurus neguyelap* titanosaur from the upper Cretaceous of Mendoza Province, Argentina [105] and *Saltasaurus loricatus* from late Cretaceous of Argentina (plate 45 of [85]). This feature and elements show both Gondwana and Laurasian worldwide distribution.

The slender and almost flat tibiae of *Imrankhanhero zilefatmi* (**Figure 11**) and *Khanazeem saraikistani* closely resemble with *Igai semkhu* [106] from the late Cretaceous of Egypt. Further the distal tibiae of *Imrankhanhero zilefatmi* (**Figure 11**) and *Khanazeem saraikistani* is anteroposteriorly expanded and subtriangular (**Figure 11**) (**Figure 14**), like those of *Igai semkhu* [106] from the late Cretaceous of Egypt, while *Gspsaurus pakistani*, *Nicksaurus razashahi* and *Balochisaurus malkani* have transversely expanded and broad distal tibia (**Figure 14**). This reveals that *Imrankhanhero zilefatmi* and *Khanazeem saraikistani* of

Indo-Pakistan subcontinent have close relation with *Igai semkhu* [106] of Egypt (Africa).

Most of the key elements of Indo-Pakistani titanosaurs resemble more closely with the Gondwanan lands than those of the Laurasian lands. Briefly this can be interpreted that during early Cretaceous Indo-Pakistan subcontinent was associated with Australia, Madagascar, Africa and also South America. Later on all these lands of Gondwana separated and travelled toward their own present destinations. This separation during Early Cretaceous resulted genetic seed dispersal and changes occurred during migration.

4. Conclusions

A glimpse on mineral deposits of different parts of Indus basin is also presented. From north to south and also east to west stratigraphic sequential variations along with their major anticlinal structural are being described here which are useful for the identification of stratigraphic sequence in different areas of Indus basin. Over than 23 years of dinosaur discoveries from Pakistan, there are sufficient and significant large bones of titanosaurs collected so far. A few complete and some nearly com-plete limb bones of titanosaurian sauropods from Pakistan and some complete limb bones referred from India are sufficient for proportion comparisons. In future the small bones collection should be preferred, so as small animal such as birds, mam-mals, snakes, crocodiles, pterosaurs and cranial materials of dinosaurs should be more elaborated for our understanding. The exposures of Vitakri Formation in Vita-kri dome proved as graveyard which yielded large number of bone assemblages and also host numerous bones and their assemblages. Although the scarcity of direct as-sociated remains, there are numerous bone assemblages found on surface as frag-mentary but indirectly provide the evidence for their association such as due to lack of duplication, size agreement and general morphological agreement. Most of these assemblages became the holotypic source of most titanosaurian sauropod and vita-krisaurid theropod dinosaurs. Some vertebrae forms alignment in some assemblages and partially embedded in host muds. The other referred assemblages are consistent with the holotypic fossils and their taxa. Each assemblage is generally found within a small area (about 10-20m*5-7m area). There are many sites appealing for exca-vation. There is certainty about the age of fossiliferous latest Maastrichtian Vitakri Formation which is bounded by well dated Maastrichtian and Early Paleocene aged strata. Pakistani titanosaurs show close relation with Australian, African (Madagas-car, Malawi and Egypt) and South American (Argentina) titanosaurs, while far rela-tion with Europe and South American titanosaurs. Saraikimasoom vitakri snout shows some relation with Mongloian (Asian) Nemegtosaurids, while slender titano-saurs Khanazeem Saraikistani and Imrankhanhero zilefatmi show close relation with Egyptian (African) titanosaurs. Although Gspsaurus pakistani with V-shaped lower teeth arcade shows endemics among titanosaurs. Fossils collected from Pakistan have significant and wide range of diagnostic features which can be used for phy-logenitic analyses with updated and broad character data set of titanosaurs fossils, Indo-Pakistan continental plate paleobiogeography and K-Pg extinction.

Conflicts of Interest

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

References

[1] Heron, A.M. and Crookshank, H. (1954) Directory of Economic Minerals of Pakistan. Geological Survey of Pakistan, Quetta, Record, 7, Part 2, 146 p.

[2] Ahmad, Z. (1969) Directory of Mineral Deposits of Pakistan. Geological Survey of Pakistan, Quetta, Record, 15, 1-200.

[3] Raza, H.A. and Iqbal, M.W.A. (1977) Mineral Deposits. In: Shah, S.M.I., Ed., *Stratigraphy of Pakistan*, Geological Survey of Pakistan, Quetta, Memoir, 12, 98-120.

[4] Kazmi, A.H. and Abbas, S.G. (2001) Metallogeney and Mineral Deposits of Pakistan. Orient Petroleum Incorporation, Islamabad, Graphic Publishers, Karachi, 264 p.

[5] Malkani, M.S., Alyani, M.I., Khosa, M.H. Somro, N., Arif, S.J., Tariq, S., Saeed, F., Khan, G. and Faiz, J. (2016) Mineral Resources of Pakistan—An Update. *Lasbela University Journal of Science & Technology*, **5**, 90-114.

[6] Malkani, M.S. and Mahmood, Z. (2016) Mineral Resources of Pakistan: A Review. Geological Survey of Pakistan, Quetta, Record, 128, 1-90.

[7] Malkani, M.S. and Mahmood, Z. (2017) Mineral Resources of Pakistan: Provinces and Basins Wise. Geological Survey of Pakistan, Quetta, Memoir, 25, 1-179.

[8] Malkani, M.S. (2020) Mineral Resources of Gilgit Baltistan and Azad Kashmir, Pakistan: An Update. *Open Journal of Geology*, **10**, 661-702. https://doi.org/10.4236/ojg.2020.106030

[9] Malkani, M.S., Mahmood, Z., Usmani, N.A. and Siraj, M. (2017) Mineral Resources of Azad Kashmir and Gilgit Baltistan, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 997, 1-40.

[10] Malkani, M.S. (2020) Cement Resources, Agrominerals, Construction, Marble, Dimension and Decor Stone Resources, Gemstone and Jewelry Resources of Pakistan. *Open Journal of Geology*, **10**, 900-942. https://doi.org/10.4236/ojg.2020.108041

[11] Malkani, M.S., Mahmood, Z., Somro, N. and Alyani, M.I. (2017) Cement Resources, Agrominerals, Marble, Construction, Dimension and Decor Stone Resources of Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 1005, 1-23.

[12] Malkani, M.S., Mahmood, Z., Somro, N. and Arif, S.J. (2017) Gemstone and Jewelry Resources of Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 1004, 1-28.

[13] Malkani, M.S., Khosa, M.H., Alyani, M.I., Khan, K., Somro, N., Zafar, T., Arif, J. and Zahid, M.A. (2017) Mineral Deposits of Khyber Pakhtunkhwa and FATA, Pakistan. *Lasbela University Journal of Science and Technology*, **6**, 23-46.

[14] Malkani, M.S., Mahmood, Z., Alyani, M.I. and Siraj, M. (2017) Mineral Resources of Khyber Pakhtunkhwa and FATA, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 996, 1-61.

[15] Malkani, M.S., Shahzad, A., Umar, M., Munir, H., Sarfraz, Y., Umar, M. and Mehmood, A. (2016) Lithostratigraphy, Structure and Economic Geology of Abbotta-

bad-Nathiagali-Kuldana-Murree Road Section, Abbottabad and Rawalpindi Districts, Khyber Pakhtunkhwa and Punjab Provinces, Pakistan. Abstract Volume, Earth Sciences Pakistan 2016, 15-17 July, Baragali Summer Campus, University of Peshawar, Pakistan. *Journal of Himalayan Earth Sciences*, ESP 2016 Volume, 168.

[16] Malkani, M.S. (2015) Mesozoic Tectonics and Sedimentary Mineral Resources of Pakistan. *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*", Shenyang, 15-20 August 2015, 261-266.

[17] Malkani, M.S., Mahmood, Z., Shaikh, S.I. and Alyani, M.I. (2017) Mineral Resources of North and South Punjab, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 995, 1-52.

[18] Malkani, M.S., Alyani, M.I., Khosa, M.H. Buzdar, F.S. and Zahid, M.A. (2016) Coal Resources of Pakistan: New Coalfileds. *Lasbela University Journal of Science and Technology*, **5**, 7-22.

[19] Malkani, M.S. and Mahmood, Z. (2017) Coal Resources of Pakistan: Entry of New Coalfields. Geological Survey of Pakistan, Quetta, Information Release, 980, 1-28.

[20] Malkani, M.S. (2012) A Review of Coal and Water Resources of Pakistan. *Journal of Science*, *Technology and Development*, **31**, 202-218.

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

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

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

[24] Malkani, M.S., Mahmood, Z., Alyani, M.I. and Shaikh, S.I. (2017) Revised Stratigraphy and Mineral Resources of Sulaiman Basin, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 1003, 1-63.

[25] Malkani, M.S. and Haroon, S. (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

[26] Malkani, M.S., Ilyas, M., Yasin, R., Abbas, A., Samiullah, K., Raza, T., Hassan, S.S.E., Fazal, R.M., Noor, A. and Malik, A. (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

[27] 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

[28] Malkani, M.S., Alyani, M.I. and Khosa, M.H. (2016) New Fluorite and Celestite Deposits from Pakistan: Tectonic and Sedimentary Mineral Resources of Indus Basin (Pakistan)—An Overview. *Lasbela University Journal of Science and Technology*, **5**, 27-33.

[29] Malkani, M.S. and Mahmood, Z. (2017) Fluorite from Loralai-Mekhtar and Celestite from Barkhan, Dera Bugti, Kohlu, Loralai and Musakhel Districts (Sulaiman Foldbelt) and Karkh Area of Khuzdar District (Kirthar Range): A Glimpse on Tectonic and Sedimentary Mineral Resources of Indus Basin (Pakistan). Geological Survey of Pakistan, Quetta, Information Release, 981, 1-16.

[30] Malkani, M.S. (2000) Preliminary Report on "Gypsum Deposits of Sulaiman Range, Pakistan". Geological Survey of Pakistan, Quetta, Information Release, 706: 1-11.

[31] Malkani, M.S. and Tariq, M. (2000) Barite Mineralization in Mekhtar Area, Loralai District, Balochistan, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 672; 1-9.

[32] Malkani, M.S. and Shah, M.R. (2014) Chamalang Coal Resources and Their Depositional Environments, Balochistan, Pakistan. *Journal of Himalayan Earth Sciences*, **47**, 61-72.

[33] Malkani, M.S., Shah, M.R., Hussain, Z. and Dhanotr, M.S.I. (2017) Coal Resources of Chamalang Coalfields, Loralai, Kohlu and Barkhan Districts, Balochistan Province, Pakistan. Geological Survey of Pakistan, Information Release, 969, 1-107.

[34] Malkani, M.S., Mahmood, Z., Shaikh, S.I. and Arif, S.J. (2017) Mineral Resources of Balochistan Province, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 1001, 1-43.

[35] Malkani, M.S., Khosa, M.H., Alyani, M.I., Somro, N., Zafar, T., Arif, J. and Aleem, M.Z. (2017) Revised Stratigraphic Setup and Mineral Deposits of Kirthar Basin (Lower Indus Basin), Pakistan. *Lasbela University Journal of Science and Technology*, **6**, 54-84.

[36] Malkani, M.S., Mahmood, Z., Somro, N. and Shaikh, S.I. (2017) Revised Stratigraphy and Mineral Resources of Kirthar Basin, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 1010, 1-59.

[37] Malkani, M.S., Mahmood, Z., Alyani, M.I. and Shaikh, S.I. (2017) Mineral Resources of Sindh, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 994, 1-38.

[38] Malkani, M.S., Islam, N., Mahmood, Z. and Rajper, R.H. (2017) New Celestite Deposits from Laki Shale and limestone, and Some Evidences of Dinosaurs and Associated Vertebrates from Laki Anticline, Sindh Province, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 1017, 1-18.

[39] Malkani, M.S. (2002) First Note on the Occurrence of Fluorite in Mula Area, Khuzdar District, Balochistan, Pakistan. Geological Survey of Pakistan, Quetta, Information Release 766, 1-11.

[40] Malkani, M.S. (2020) Revised Stratigraphy and Mineral Resources of Balochistan Basin, Pakistan: An Update. *Open Journal of Geology*, **10**, 784-828. https://doi.org/10.4236/ojg.2020.107036

[41] Malkani, M.S., Mahmood, Z., Arif, S.J. and Alyani, M.I. (2017) Revised Stratigraphy and Mineral Resources of Balochistan Basin, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 1002, Quetta, 1-38.

[42] Jones, A.G., Manistere, B.E., Oliver, R.L., Willson, G.S. and Scott, H.S. (1961) Reconnaissance Geology of Part of West Pakistan. Colombo Plan Co-Operative Project Conducted and Compiled by Hunting Survey Corporation, Government of Canada, Toronto, 550 p.

[43] Shah, S.M.I. (1977) Precambrian. In: Shah, S.M.I., Ed., *Stratigraphy of Pakistan*, Geological Survey of Pakistan, Quetta, Memoir, 12, 1-5.

[44] Shah, S.M.I. (1977) Paleozoic. In: Shah, S.M.I., Ed., *Stratigraphy of Pakistan*, Geological Survey of Pakistan, Quetta, Memoir, 12, 5-29.

[45] Fatmi, A.N. (1977) Mesozoic. In: Shah, S.M.I., Ed., *Stratigraphy of Pakistan*, Geological Survey of Pakistan, Quetta, Memoir, 12, 29-56.

[46] Cheema, M.R., Raza, S.M. and Ahmad, H. (1977) Cainozoic. In: Shah, S.M.I., Ed., *Stratigraphy of Pakistan*, Geological Survey of Pakistan, Quetta, Memoir, 12, 56-98.

[47] Shah, S.M.I. (2002) Lithostratigraphic Units of the Sulaiman and Kirthar Provinces, Lower Indus Basin, Pakistan. Geological Survey of Pakistan, Quetta, Record, 107, 63 p.

[48] Kazmi, A.H. and Abbasi, I.A. (2008) Stratigraphy and Historical Geology of Pakistan. Department and National Centre of Excellence in Geology, University of Peshawar, Peshawar, 524 p.

[49] Malkani, M.S. and Mahmood, Z. (2016) Revised Stratigraphy of Pakistan. Geological Survey of Pakistan, Quetta, Record, 127, 1-87.

[50] Malkani, M.S. and Mahmood, Z. (2017) Stratigraphy of Pakistan. Geological Survey of Pakistan, Quetta, Memoir, 24, 1-134.

[51] 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

[52] 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

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

[54] 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.

[55] Malkani, M.S. (2004) Saurischian Dinosaurs from Late Cretaceous of Pakistan. 5*th Pakistan Geological Congress*, Islamabad, 14-15 April 2004, 71-73.

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

[57] 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

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

[59] 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.

[60] Malkani, M.S. (2015) Titanosaurian Sauropod Dinosaurs from Pakistan. *Abstract Volume*, 12*th Symposium on* "*Mesozoic Terrestrial Ecosystems* (*MTE* 12), *and* 3*rd Symposium of International Geoscience Program* (*IGCP* 608) "*Cretaceous Ecosys-*

tem of Asia and Pacific", Shenyang, 15-20 August 2015, 93-98.

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

[62] Malkani, M.S. (2020) First Skull of Medium Sized Titanosaur from 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

[63] Malkani, M.S. (2020) First Snout with Complete Teeth Row of Titanosaur from Indo-Pakistan Subcontinent 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

[64] 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

[65] Malkani, M.S., Mantilla, J.A.W., Zalmout, I.S.A. and Gingerich, P.D. (in process) New Titanosaur Remains from the Vitakri Formation (Late Cretaceous) of Sangiali, Balochistan, Pakistan. Contributions from the Museum of Paleontology, University of Michigan, Ann Arbor.

[66] 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

[67] Wilson, J.A., Malkani, M.S. and Gingerich, P.D. (2001) New Crocodyliform (Reptilia, Mesoeucrocodylia) form the Upper Cretaceous Pab Formation of Vitakri, Balochistan (Pakistan). *Contributions from Museum of Paleontology*, *Univ. of Michigan*, **30**, 321-336.

[68] Malkani, M.S. (2014) Theropod Dinosaurs and Mesoeucrocodiles from the Terminal Cretaceous of Pakistan. 2*nd Symposium International Geoscience Program* (*IGCP* 608) "*Cretaceous Ecosystem of Asia and Pacific*", Tokyo, 4-6 September 2014, 169-172.

[69] Malkani, M.S. (2013) New Pterosaur from the Latest Cretaceous Terrestrial Strata of Pakistan. *Abstract Book of* 9*th Symposium on Cretaceous System*, Ankara, 1-5 September 2013, 62.

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

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

[72] Malkani, M.S. (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

[73] Malkani, M.S. (2014) Records of Fauna and Flora from Pakistan; Evolution of Indo-Pakistan Peninsula. *Abstract Volume of* 2*nd Symposium of IGCP* 608 "*Cretaceous Ecosystem of Asia and Pacific*", Tokyo, 4-6 September 2014, 165-168.

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

[75] 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.

[76] Malkani, M.S., Somro, N. and Arif, S.J. (2018) A New Pes Footprint of Sauropod Dinosaur Discovered from the Latest Cretaceous of Pakistan. Researchgate.net, Research, 1 p.

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

[78] Mathur, U.B. and Pant, S.C. (1986) Sauropod Dinosaur Humeri from Lameta Group (Upper Cretaceous) of Kheda District, Gujarat. *Journal of the Palaeontological Society of Indi*a, **31**, 22-25.

[79] Dwivedi, G.N., Mohabey, D.N. and Bandyopadhyaya, S. (1982) On the Discovery of Vertebrate Fossils from Infratrappean Lameta Beds, Kheda District, Gujarat. *Current Trends in Geology*, **7**, 79-87.

[80] Sajid, M., Ali, L., Khan, M.Y., Khan, M. and Qadri, S.M.T. (2023) Integrated Geophysical and Geochemical Analyses for Assessment of Potential Coal Prospects in Tirah Area, Khyber Pakhtunkhwa, Pakistan. *Energies*, **16**, Article No. 6541. https://doi.org/10.3390/en16186541

[81] Tariq, M., Malkani, M.S., Qureshi, I.H. and Ahmed, S.A. (1991) Geology of Shirinab Area 34K/10, Kalat District, Balochistan, Pakistan. Geological Survey of Pakistan, Quetta, Information Release, 543.

[82] Abbas, S.G., Kakepoto, A.A. and Ahmad, M.H. (1998) Iron Ore Deposits of Dilband Area, Mastung District, Kalat Division, Balochistan. Geological Survey of Pakistan, Quetta, Information Release, 679, 1-19.

[83] Kakepoto, A.A. (2014) Dilband Ironstone Deposits, Balochistan, Pakistan. (In Process Thesis for PhD under Sindh University Jamshoro).

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

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

[86] Wilson, J.A., Malkani, M.S. and Gingerich, P.D. (2005) A Sauropod Braincase from the Pab Formation (Upper Cretaceous, Maastrichtian) of Balochistan, Pakistan. *Gondwana Geological Magazine*, **8**, 101-109.

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

[88] Vredenburg, E.W. (1908) The Cretaceous Orbitoides of India. Geological Survey of India, Records, 36, 171-213.

[89] Wnuk, C. (2022) Climatic Control on the Subcontinent's Cenozoic Coal Formation and the Potential for Additional Undiscovered Thar-Like Coal Deposits. *Earth-Science Reviews*, **235**, Article ID: 104237. https://doi.org/10.1016/j.earscirev.2022.104237

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

[91] Díez Díaz, V., Mocho, P., Paramo, A., Escaso, F., Marcos-Fernandez, F. and Sanz, J.L. (2016) A New Titanosaur (Dinosauria, Sauropoda) from the Upper Cretaceous of Lo Hueco (Cuenca, Spain). *Cretaceous Research*, **68**, 49-60. https://doi.org/10.1016/j.cretres.2016.08.001

[92] Mannion, P.D., Upchurch, P., Barnes, R.N. and Mateus, O. (2013) Osteology of the Late Jurassic Portuguese Sauropod Dinosaur Lusotitan Atalaiensis (Macronaria) and the Evolutionary History of Basal Titanosauriformes. *Zoological Journal of the Linnean Society*, **168**, 98-206. https://doi.org/10.1111/zoj.12029

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

[94] Poropat, S.F., Upchurch, P., Mannion, P.D., Hocknull, S.A., Kear, B.P., Sloan, T., Sinapius, G.H.K. and Elliott, D.A. (2015) Revision of the Sauropod Dinosaur *Diamantinasaurus matildae* Hocknull *et al.* 2009 from the Middle Cretaceous of Australia: Implications for Gondwanan Titanosauriform Dispersal. *Gondwana Research*, **27**, 995-1033. https://doi.org/10.1016/j.gr.2014.03.014

[95] Rigby, S.L., Poropat, S.F., Mannion, P.D., Pentland, A.H., Sloan, T., Rumbold, S.J., Webster, C.B. and Elliott, D.A. (2022) 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

[96] 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

[97] Wilson, J.A., Mohabey, D.M., Lakra, P. and Bhadran, A. (2019) Titanosaur (Dinosauria, Sauropoda) Vertebrae from the Upper Cretaceous Lameta Formation of Western and Central India. Contributions from the Museum of Paleontology, University of Michigan, **33**, 1-27.

[98] Curry Rogers, K. (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

[99] Díez Díaz, V., Garcia, G., Pereda-Suberbiola, X., Jentgen-Ceschino, B., Stein, K., Godefroit, P. and Valentin, X. (2018) The Titanosaurian Dinosaur Atsinganosaurus Velauciensis (Sauropoda) from the Upper Cretaceous of Southern France: New Material, Phylogenitic Affinities, and Paleobiogeographic Implications. *Cretaceous Research*, **91**, 429-456. https://doi.org/10.1016/j.cretres.2018.06.015

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

[101] Malkani, M.S. (2007) First Diagnostic Fossils of Late Cretaceous Crocodyliform (Mesoeucrocodylia, Reptilia) from Vitakri Area, Barkhan District, Balochistan, Pakistan. In: Ashraf, M., Hussain, S.S., and Akbar, H.D., Eds., Contribution to Geology of Pakistan. A Publication of the National Geological Society of Pakistan, Pakistan Museum of Natural History, Islamabad, Pakistan, 241-259.

[102] Khosla, A. and Lucas, S.G. (2023) Review of the Cretaceous Dinosaurs from India

and Their Paleobiogeographic Significance. *Acta Geologica Polonica*, **73**. https://doi.org/10.24425/agp.2023.145623

[103] Smith, J.B., Vann, D.R. and Dodson, P. (2005) Dental Morphology and Variation in Theropod Dinosaurs: Implications for the Taxonomic Identification of Isolated Teeth. *The Anatomical Record, Part A*, **285**, 699-736. https://doi.org/10.1002/ar.a.20206

[104] Mannion, P.D., Upchurch, P., Schwarz, D. and Wings, O. (2019) Taxonomic Affinities of the Putative Titanosaurs from the Late Jurassic Tendaguru Formation of Tanzania: Phylogenitic and Biogeographic Implications for Eusauropod Dinosaur Evolution. *Zoological Journal of the Linnean Society*, **185**, 784-909. https://doi.org/10.1093/zoolinnean/zly068

[105] Gonzalez Riga, B.J. (2003) A New Titanosaur (Dinosauria, Sauropoda) from the Upper Cretaceous of Mendoza Province, Argentina. Ameghiniana (Rev. Asoc. Paleontol. Argent.), **40**, 155-172.

[106] Gorscak, E., Lamanna, M.C., Schwarz, D., Díaz, V.D., Salem, B.S., Sallam, H.M. and Wiechmann, M.P. (2023) A New Titanosaurian (Dinosauria: Sauropoda) from the Upper Cretaceous (Campanian) Quseir Formation of the Kharga Oasis, Egypt. *Journal of Vertebrate Paleontology*, **42**, e2199810.