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New Data on Coal, Gypsum, Iron and Silica Sand Deposits and Geochemical Exploration (Pakistan): Revision of 25 Years History of Dinosaur Discoveries from Pakistan

Muhammad Sadiq Malkani

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

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Abstract

Discoveries of many coal seams at depths by drilling carried by Geological Survey of Pakistan in Sor Range and Harnai Gochina, extended the coal seams at depth which is challenge for mine owners to exploit feasibly. Bed to bed gypsum samplings (and their chemical analyses) of huge gypsum deposits from Sulaiman foldbelt is a base for industrialist and also planers to develop cement and gypsum industries to increase export and foreign exchange for the development of area and Pakistan. Low and high grade sedimentary iron deposits, silica sand and uranium host rocks and their extensions in Sulaiman and Kirthar foldbelts are presented. Anomalies of a few base metals arise as a result of geochemical exploration carried at part of Loralai District of Balochistan. Theropod dinosaurs were frequent in India, while Poripuchian titanosaurs (Sauropoda, Dinosauria) were frequent in Pakistan. Besides some ichnotaxa, many bone taxa such as 1 titanosauriform, 14 titanosaurian sauropod (including one new titanosaur), and 3 theropod dinosaurs are established from Pakistan. Among these 12 titanosaur species and 3 theropod species are named in about 10 km^2 area of Vitakri dome and 2 titanosaur species are named in about a few hundred square meter area of Mari Bohri (Kachi Bohri) which is about 10 km westward from Vitakri dome. Pakistan is a unique country which discoverd 14 diversified titanosaurs in a short area and also in a short period (67 - 66 million years ago/Ma). About 400 bones found from a few meter thick upper part of upper shale horizon of latest Maastrichtian Vitakri Formation which is base for titanosaur taxa. Cranial material is in low fraction (but include significant diverse snouts), caudal vertebrae are prominent, the cervicals, dorsals and sacrals have significant numbers, forelimb and hind limb bones have balanced fraction. Humeri, femora and tibiae are most common. To know the position of Pakistani titanosaurs among titanosaurs and sauropods, there is a need to extend list of characters for phylogenetic analyses. This broad feature list should include main characters of titanosaurs from Pakistan and also from global world.

Keywords

Coal, Gypsum, Ironstone, Silica sands, Geochemical Exploration, Dinosaurs, Titanosauriformes, Titanosaurs, Theropods, Revision, Balochistan, Pakistan

1. Introduction

Mineral resources of Pakistan were reported by many workers since 1954 [1] [2] [3] [4] [5] and more recently reported by [6] [7] [8]. Mineral resources of each province was presented such as Balochistan [9] [10] [11] [12] [13], Khyber Pakhtunkhwa [12] [13] [14] [15], North and South Punjab [16] [17], Saraikistan/South Punjab [17], Sindh [18], Gilgit Baltistan and Azad Kashmir [12] [13] [19] [20]. Mineral resources of each basin was presented such as Balochistan basin [21] [22], Hindukush-Karakoram basin [6] [7] [8] [19] [20], Kohistan-Ladakh basin [6] [7] [8] [19] [20], Khyber-Hazara-Neelam basin (uppermost Indus) [6] [7] [8] [19] [20], Kohat-Potwar-Kotli basin (upper Indus) [6] [7] [8], Sulaiman Basin [9] [11] [23] [24] [25] and Kirthar basin [26] [27]. Recently coal [6] [7] [8] [28]-[41], gypsum [6] [7] [8] [42]-[49], barite [6] [7] [8] [50], fluorite [6] [7] [8] [51] [52] [53], and iron deposits [6] [7] [8], especially Dilband ironstone [54] [55] [56], silica sand [6] [7] [8] were also reported from different localities in Pakistan. Most of these minerals are found in different strata. Stratigraphy of Pakistan was presented by many workers [57]-[63]. Here new data on drilling logs of Sor Range-Deghari and Harnai-Gochina-Sangan-e-Pain (north and western extremity of Sibi trough), gypsum resources, some minerals of Dera Bugti Districts, and Geochemical exploration in part of Loralai District of Balochistan (Pakistan) are being presented. From India, the research on dinosaurs is continuing since about 2 centuries [64]. At the start of third millennium, the first bone (distal femur) of dinosaur from Sangiali locality of Vitakri area of Barkhan District, Balochistan, Pakistan was discovered by present author (MSM) which was later reported in late 2000 [65]. In the second time about 100 small, medium and large pieces of bones were also discovered by MSM from Sangiali locality on October 21, 2000. These bones from Sangiali were shifted in 2000-2001 to Museum of Paleontology, University of Michigan, USA for preparation. Most of the reported and so far not reported (round about 3 thousand) bones were found by me (MSM) during the year 2000 and 2001. A few significant bones were collected in 2005 and 2006, while most of the observed bone during 2005 and 2006 field works were left in the field for future studies. A series of papers on these major bones found from Sulaiman foldbelt (middle Indus foldbelt) which became the basis for 14 titanosaurian sauropods and 3 theropod dinosaurs were presented in 2003 [66] [67], 2004 [68], 2005 [69], 2006 [70] [71] [72] [73], 2008 [74], 2009 [75], 2010 [76] [77], 2013 [78], 2014 [79], 2015 [80] [81], 2016 [82], 2019 [83], 2020 [84] [85] [86] [87], 2021 [88] [89], 2022 [90], and 2023 [17] [54]. A few bones of late Jurassic-Early Cretaceous titanosauriform (dinosaur) were found in 2002 from Khuzdar District of Kirthar Foldbelt (Lower Indus foldbelt) which was reported in 2003 [91]. All of the type and referred fossil bones of dinosaurs reported from Pakistan so far are discovered by present author (M. Sadiq Malkani) in the field. Brief history of discoveries of dinosaurs and associated bones from latest Cretaceous of Sulaiman foldbelt are mentioned in pages 65-66 of [66], pages 108-109 of [70] and pages 7-8 of [72]. Some new information is being added as below. I (M. Sadiq Malkani) went in the Sangiali dinosaur locality with Philip D. Gingerich (PDG) (and Iyad Zalmout) for few hours to take bones from mid Sangiali on October 21, 2000. The vehicles were stopped at the outer entrance of Sangiali locality. When I came out from vehicle and collected my field bag and started toward bone site. Then I saw PDG was rushing and walking hastily on the bank of Sangiali stream while Iyad Zalmout was rushing and walking hastily on the northern peak of Sangiali locality. PDG crossed the site (but not observed the bones) and went more than 50 m ahead. I (MSM) reached the site and discovered the bones in the mid Sangiali site and called back PDG to take bone. Total about 100 bones (including small, medium and large sizes) of Sangiali locality were shifted to Museum of Paleontology, University of Michigan, USA for preparation. The grid reference of mid Sangiali locality with field number 2000-001 is 29.699478N, 69.399227E (29.69810N and 29.69812N and longitudes 69.39872E and 69.39882E (29.698225N, 69.398765E; 29˚41.894N; 69˚23.926E) which yielded round about 100 bones found from the upper part of upper shale unit of Vitakri Formation situated just below the upper sandstone unit of Vitakri Formation (Table 1 of [90]). Iyad Zalmout collected a rounded rock fragment from locality field number 2000-002 is 29.699478N, 69.399227E which he thinks looks like bone. This second locality is about 50 m north of mid sangiali fossil locality and consists of exposed upper surface of upper sandstone unit of latest Maastrichtian Vitakri Formation or lower part of Early Paleocene Sangiali Formation. So this second site is not bone locality. Dr. Jeffrey A. Wilson Mantilla visited GSP, Quetta museum for a few days during March 21-24, 2001. 6 bones from different sites of Vitakri and surrounding were also sent in 2001 to Museum of Paleontology, University of Michigan, USA for preparation. Dr. David A. Krauss of Bostan College USA visited few days GSP, Quetta museum during May 20-26, 2001 and also visited for few hours Sangiali and Shalghara localities of Vitakri Dome on May 25, 2001 with me. He takes 3 bones for preparation to Bostan College, USA ([54], page 1127). So far all of the holotypic and referred bones of vertebrates from the Vitakri Formation were collected by a single officer (MSM) with few assistants [92]. Beside these many footprints and trackways of archosaurs are also discovered [89]. Many bones from India [93] [94] [95] [96] [97] were also referred to some Pakistani titanosaurs. During 25 years history of dinosaur discoveries from Pakistan a series of papers were reported. Here the purpose of revision of dinosaurs is being carried to save time for readers.

Institutional Abbreviations:

GSP, Geological Survey of Pakistan, Quetta, Pakistan.

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

2. Materials and Methods

Being field geologist, the materials was collected during numerous field visits and seasons. Further for revision on dinosaur of Pakistan, the materials are a series of papers about dinosaurs published during previous two and half decade started after first discovery in Pakistan. Methods applied here are many disciplines of geological description and Paleontological diagnosis, comparison and description of fossils.

3. Results and Discussion

Here the results and discussion are represented in the three major subjects. The first major subject is about the new data on some coal, gypsum, iron and silica sand deposits of Pakistan. The second major subject is the geochemical exploration of part of Loralai District, Balochistan. The third major subject is the revision of 25 years history of dinosaur discoveries from Pakistan.

3.1. New Data on Coal, Gypsum, Iron and Silica Sand Deposits of Pakistan

New data is presented as below.

3.1.1. Drilling Data of Sor Range-Deghari and Harnai-Gochina Coalfields, Balochistan (Pakistan)

Recently coal resources of Pakistan are presented by [28]-[41]. Coal discoveries by drilling (**Figure 1**, **Figure 2**) at Sor Range and Harnai Gochina are presented.

Drilling data of Sor Range-Deghari Coalfields, Balochistan (Pakistan): In Sor Range-Deghari syncline, four drill holes (SR-1b, SR-2, SR-3 and SR-4) in 1989 was drilled by the Geological Survey of Pakistan for coal exploration. Drill holes encounter in the surface alluvium, Oligocene Nari, Eocene Kirthar, Kingri and Toi Formations. Drill hole **SR-1b** encounter guide marker conglomerate at depth of 1332 foot. Then the first thin coal seam of 4 inch, second thin coal seam of 3 inch and third thick coal seam of 1 foot and 6 inch (1’ 6”) were encountered during depth 1387 to 1493 foot (**Figure 1**). This drill hole closed at depth 1571’. Drill hole **SR-2** encounter marker conglomerate at depth of 1618 foot. The first main coal seam of 1 foot and 5 inch (1’ 5”) encountered. Then the three thin coal seams of 6 inch, 5 inch and 3 inch were encountered after the main coal seam (**Figure 1**). This drill hole was stopped at depth 1772’. Drill hole **SR-3** encounter marker conglomerate at depth of 1561 foot. Then after the conglomerate, the core loss occurred in about 10 feet single run. During this run the coal cuttings were observed in the drilling mud. Drilling continued upto 1735 foot depth with

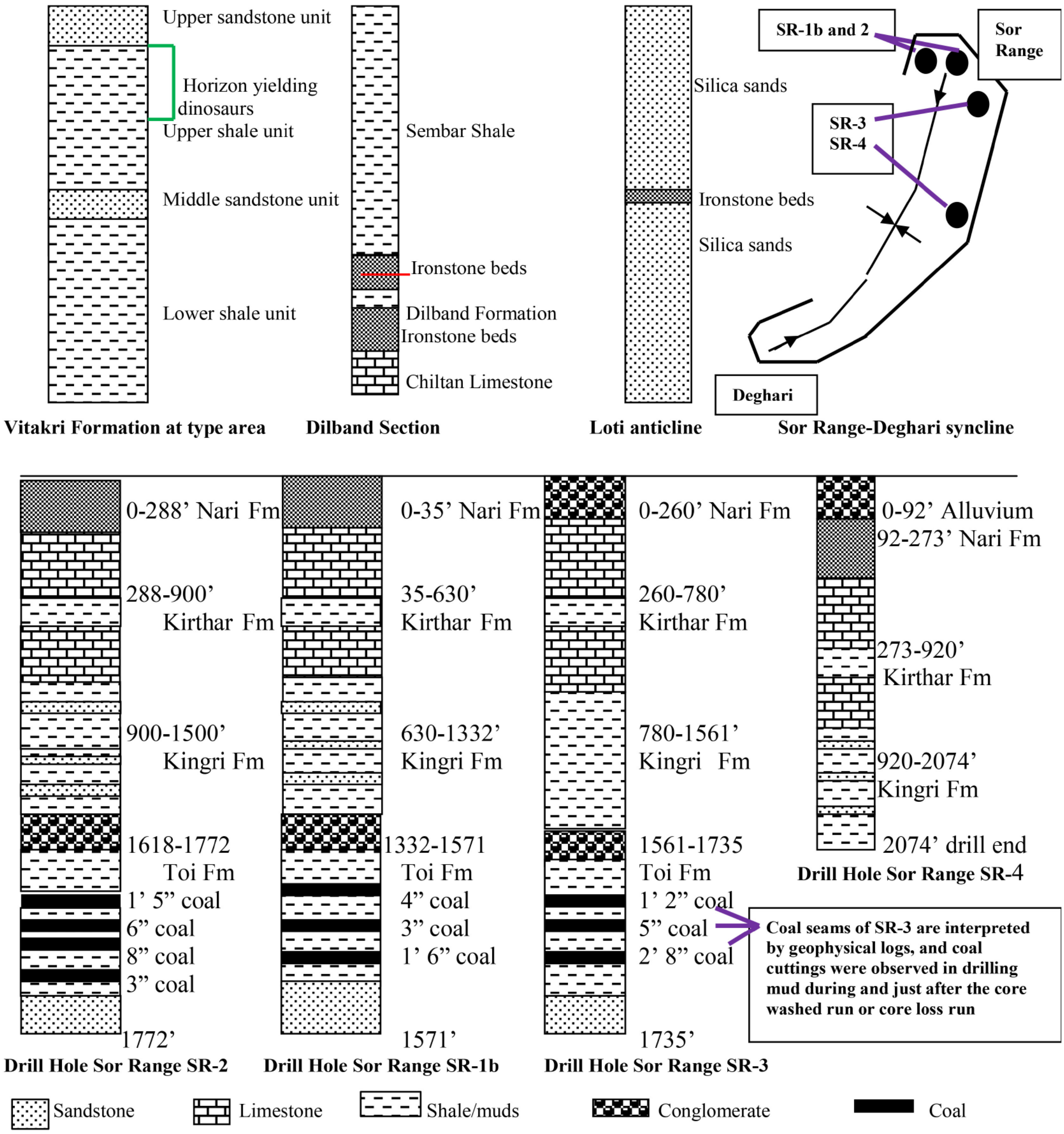

Figure 1. **Upper 3 sections,** representing dinosaur horizon in latest Cretaceous (latest Maastrichtian) Vitakri Formation, Johan-Dilband iron stone in Late Jurassic-Early Cretaceous Dilband Formation, Loti ironstone and silica sands in Oligocene Chitarwata Formation. Further location of 4 drill holes at Sor Range is tentatively shown. **Lower four sections,** Four Drill Hole logs of Sor Range-Deghari coalfield (SR-1, SR-2, SR-3 and SR-4). Geologically the drill holes are located in the syncline core of Sor Range-Deghari syncline. The Lithologic logs are not on scale. Fm for Formation.

well core recovery but no coal seam was observed. Geophysical logging was operated and their interpretation resulted into three coal seams 1' 2", 5" and 2' 8" (Figure 1) with composite thickness of 4' 3" (Figure 1) in a single run of about 10 foot when core loss occurred. These coalfields found in the long and arc shape

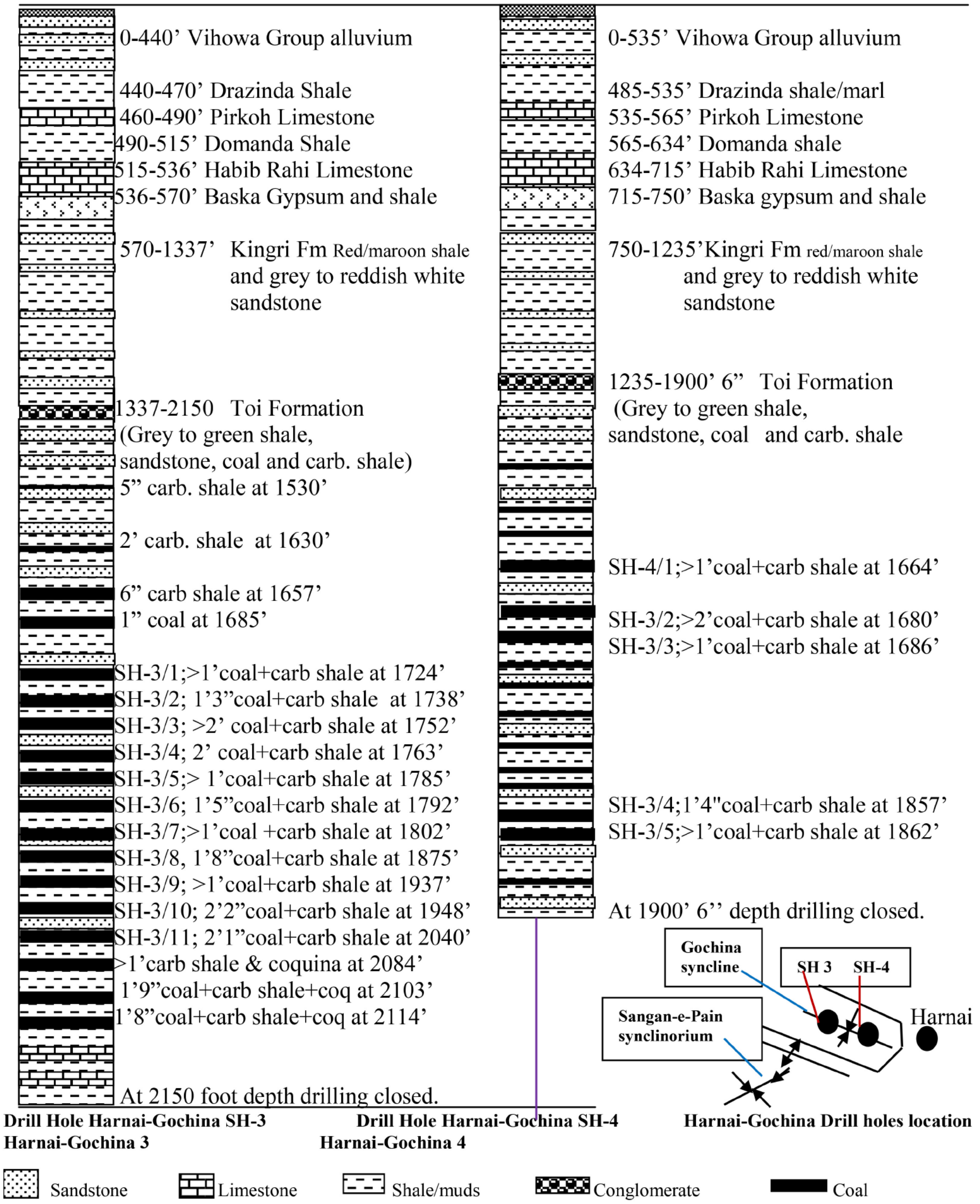

Figure 2. Two drill hole logs of Harnai-Gochina coalfield drilled at southwest Gochina (SH-3) and northeast Gochina (SH-4), geologically located in the axis of Gochina syncline are shown. Lithologic logs are not on scale. Carb shale is for Carbonaceous shale.

syncline (Figure 1) with low to moderate dips. Coal is hosted by Early Eocene Toi Formation (30 - 75 m). Coal reserves estimated 4.77 mt [38], 9.3 mt workable reserves [1] 53 mt total reserves [39] and 34 mt [40] which included 6 mt proved, 12 mt probable and 16 mt as possible resources, and 35.70 mt coal reserves of Sor Range and 14.40 mt coal reserves of Deghari coalfields [41]. The recent investigations show 54.5 mt total reserve of Sor Range-Sinjidi-Deghari coalfields [30]. The reference [30] increased the coal reserves on the basis of new coal exploration (**Figure 1**). According to [30] the Sor Range reserves are 39.44 mt with detail as measured 6.48 mt, indicated 12.96 mt and inferred and hypothetical reserves at 20 mt and Sinjidi-Deghari reserves are 15.08 mt with detail as measured reserves 3.36 mt, indicated reserves 6.72 mt, inferred and hypothetical reserves at 5 mt.

Drilling data of Harnai-Gochina-Sangan-e-Pain Coalfields, Balochistan: Two drill holes (SH-3 and SH-4) (**Figure 2**) were drilled by Geological Survey of Pakistan and make coal seams discovery in Toi Formation. Drill holes encounter in the recent and subrecent alluvium, Oligocene-Miocene Vihowa Group, Early to Late Eocene Kahan Group including Habib Rahi Limestone, Domanda Shale, Pirkoh Limestone and Drazinda shale, Early Eocene Baska, Kingri and Toi Formations.

Drill hole **SH-3** encounter marker conglomerate at depth of 1337 foot and then about 20 coal seams like Chamalang coalfields were discovered. Here main 11 coal seams were discovered varying thickness from 1' to 2' coal in every coal seam (**Figure 2**). This drill hole ended at depth 2150'. Drill hole **SH-4** encounter marker conglomerate at depth of 1235 foot. Then about 20 coal seams were discovered. Here main 5 coal seams were discovered varying thickness from 1' to 2' coal in every coal seam (**Figure 2**). This drill hole ended at depth at 1900' 6". However if this drilling will continue for 100 - 200 feet, it is possible it may discover more workable coal seams like the drill hole SH-3. Drill holes located in the limbs of Gochina syncline (**Figure 2**). Shahrig areas have high dips (60 - 800) and are faulted. Reference [40] estimated 47 mt with 8 mt measured, 16 mt indicated and 23 mt inferred. Reference [41] estimated 86 mt of coal with 16.7 mt proven reserves and 69.7 mt inferred reserves upto mineable depth of 1200 m. Recently [30] also estimated total reserves of 86.4 mt with detail as 20.9 mt of measured reserves (exposure to 0.4 km depth), 41.8 mt of indicated reserves (0.4 - 1.2 km depth) and 23.7 mt of inferred reserves (1.2 km to 1800 m depth). Reference [30] increased the coal reserves on these coal discoveries.

3.1.2. New data on Gypsum Deposits of Sulaiman Foldbelt, Balochistan, South Punjab and Khyber Pakhtunkhwa (Pakistan)

Gypsum deposits reported by [57] are Spintangi, Nakus, Dungan, Bala Dhaka, Bahlol, Mawand and Mach. Evaluation of Spintangi gypsum deposits carried by [42]. Recently huge gypsum was discovered by present author [6] [7] [8] [9] [10] [42]-[49]. Total 122 gypsum samples from different localities of Barkhan and Kohlu districts, and Manjhail Kharar of Taunsa District were collected from different beds (**Figures 3-5**) and major constituents CaO, SO_3, H_2O^{+-}, MgO and insoluble matter were chemically analyzed (**Table 1**). Among these 117 samples are from Baska and 5 samples from Domanda shale were collected. Among these

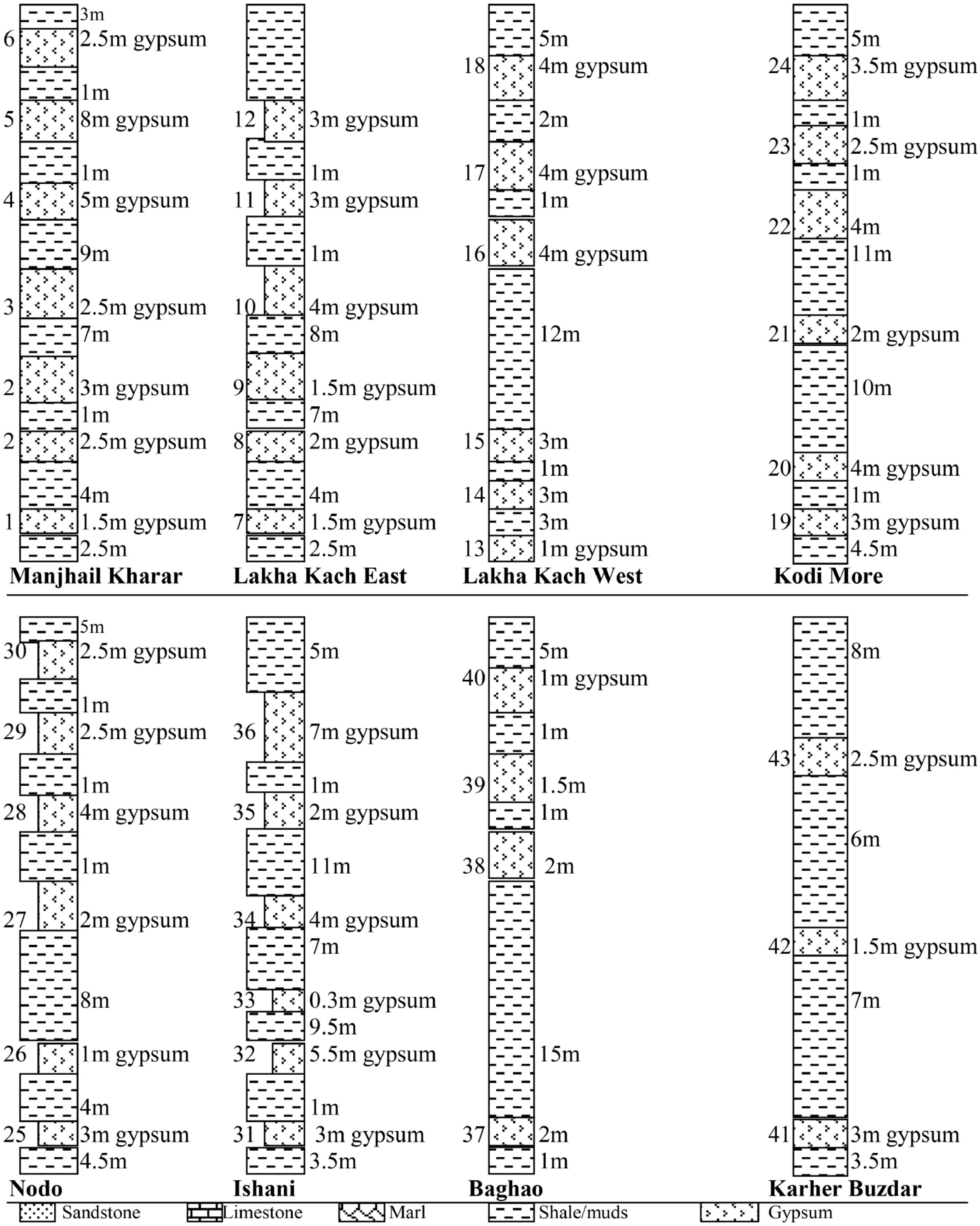

Figure 3. Lithologic logs of each bed of gypsum and alternated shale/rocks of Baska Formation. Gypsum sample number is marked by numerical just before the gypsum beds, for example 1 - 6 (Gypsum 1 to 6) of Manjhail Kharar section. Thickness of each gypsum bed and shale/rocks are shown in front of bed in meter/m. Same is applied for (Figure 4 & Figure 5). Lithologic logs are not on scale.

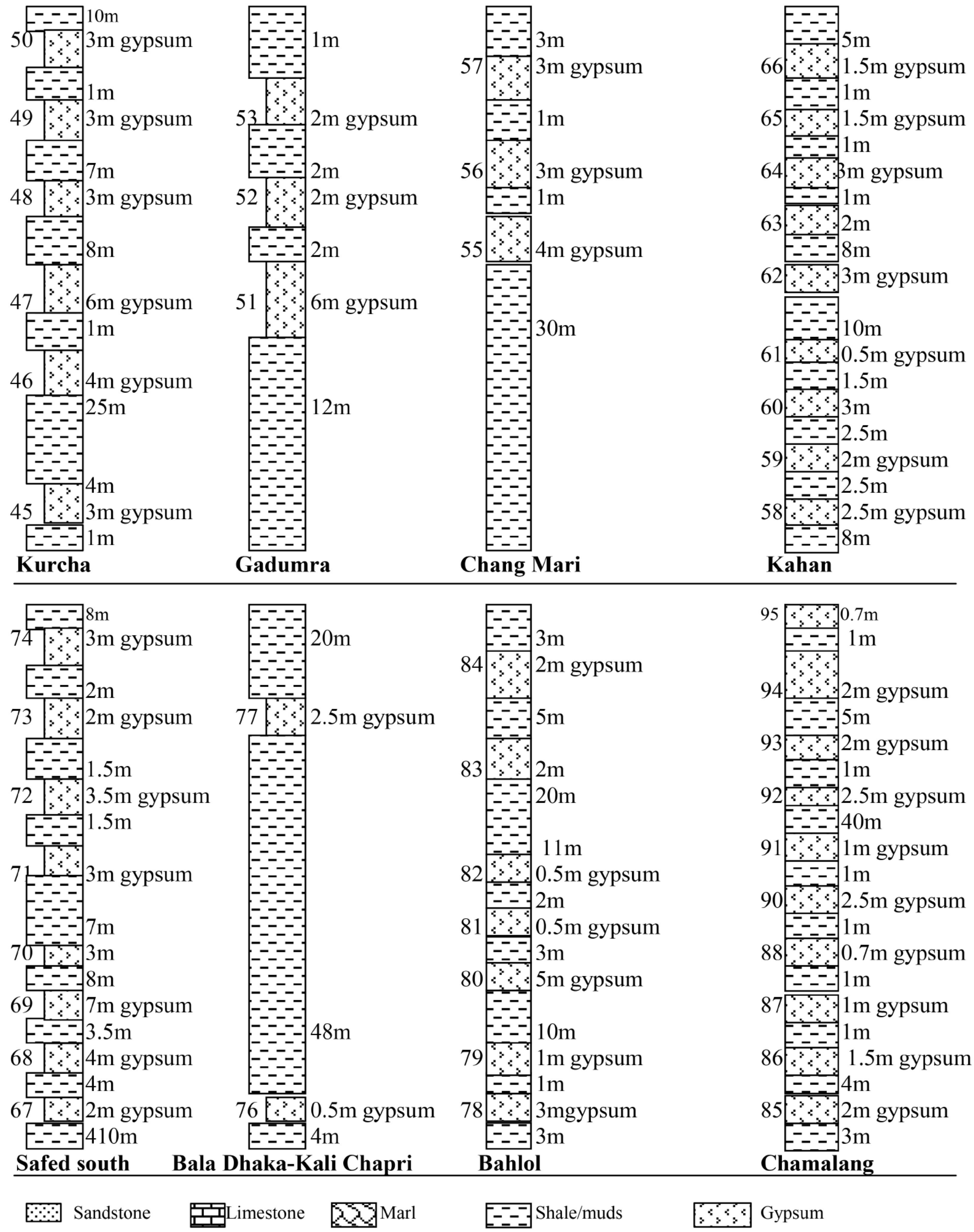

Figure 4. Lithologic logs of each bed of gypsum and alternated shale/rocks of Baska Formation. Lithologic logs are not on scale.

16 gypsum samples from Baska and Domanda gypsum were chemically analyzed (Table 2) for almost complete constituents to know the impurities. The chemical

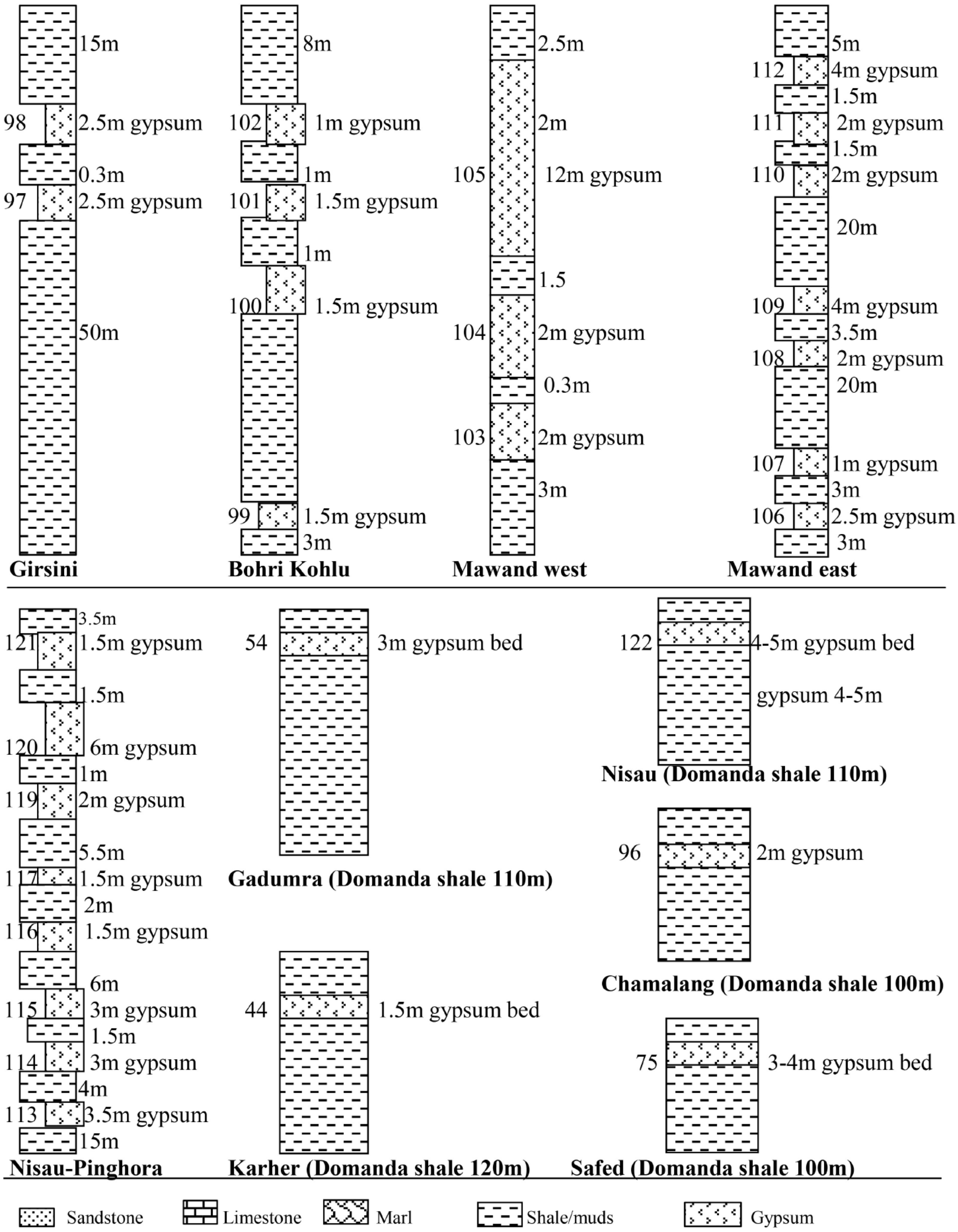

Figure 5. Lithologic logs of each bed of gypsum and alternated shale/rocks of Baska Formation (at Nisau-Pinghora section) and Domanda Formation (at Karher, Gadumra, Safed, Chamalang and Nisau sections). Lithologic logs are not on scale.

analyses of gypsum show impurities 1% - 2%. From Dera Bugti district area one gypsum sample from Baska gypsum of Sham Wadera Shero Bugti area and 2 samples from Domanda shale of Pirkoh area were collected and analyzed (Table 3) along with other mineral samples.

Table 1. Chemical analyses of gypsum samples from different localities of Barkhan and Kohlu Districts of Balochistan and a few samples for comparison from Manjhail Khara locality of Taunsa District, South Punjab. Chemical analyses results were received in 2001. Samples (Tables 1-7) were analyzed by Chemistry Division, Geological Survey of Pakistan, Quetta. Symbol ditto" in tables represents the value same as above, and D after sample number is for duplicate.

Locality	GSP/Chem/ Lab No.	Sender's No.	CaO%	SO_3%	H_2O^{+-}%	MgO%	Insoluble Matter %	Analyzed by	Approved by
Manjhail Kharar	2346-1	Gyp-1	30.84	48.36	18.43	0.50	0.30	Azhar Khan, Superintendent Chemist	Shamsher Khan, Chief Chemist
"	" -2	Gyp-2	32.24	45.75	18.62	0.50	0.32	"	"
"	" -3	Gyp-3	30.84	47.43	17.62	2.01	0.58	"	"
"	" -4	Gyp-4	32.24	46.64	18.44	traces	0.32	"	"
"	" -5	Gyp-5	30.84	47.33	18.45	1.08	0.28	"	"
"	" -6	Gyp-6	30.84	47.84	18.36	0.50	0.12	"	"
Lakha Kach East Limb	2347 -1	Gyp-7	29.44	46.81	16.30	1.01	0.36	Hasham ul Haque, Senior Chemist	Azhar Khan, Superintendent Chemist
"	" -2	Gyp-8	33.65	44.81	18.99	1.01	0.40	"	"
"	" -3	Gyp-9	32.25	45.88	17.71	0.00	0.46	"	"
"	" -4	Gyp-10	29.44	44.65	18.40	1.01	0.28	"	"
"	" -5	Gyp-11	32.25	46.63	18.36	0.00	0.36	"	"
"	" -6	Gyp-12	30.84	46.82	19.10	1.01	0.14	"	"
Lakha Kach West Limb	2348 -1	Gyp-13	29.44	46.14	18.37	0.50	0.36	Zaheer Ali Khan, Chemist	Azhar Khan, Superintendent Chemist
"	" -2	Gyp-14	32.25	45.86	17.33	0.50	0.18	"	"
"	" -3	Gyp-15	30.84	36.38	18.25	1.00	0.34	"	"
"	" -4	Gyp-16	31.54	47.78	17.63	0.50	0.22	"	"
"	" -5	Gyp-16D	32.25	46.04	16.90	0.50	0.24	"	"
"	" -6	Gyp-17	32.25	47.55	17.73	0.50	0.52	"	"
"	" -7	Gyp-18	30.84	45.14	17.54	0.50	0.26	"	"
Kodi More	2351 -1	Gyp-19	32.25	46.12	18.27	trace	0.38	Hasham ul Haque, Senior Chemist	Azhar Khan, Superintendent Chemist
"	" -2	Gyp-20	32.25	46.29	18.47	0.50	0.10	"	"
"	" -3	Gyp-21	31.55	46.36	19.09	0.50	0.10	"	"
"	" -4	Gyp-22	32.25	45.95	18.90	0.50	0.06	"	"
"	" -5	Gyp-23	32.25	46.46	19.22	1.00	0.08	"	"
"	" -6	Gyp-24	32.25	45.88	19.14	0.50	0.16	"	"
Nodo	" -7	Gyp-25	32.25	45.88	19.38	0.50	0.20	"	"
"	" -8	Gyp-25D	32.25	45.81	19.33	0.50	0.28	"	"
"	2354-1	Gyp-26	31.54	45.78	17.25	0.50	0.60	Zaheer Ali Khan, Chemist	Azhar Khan, Superintendent Chemist

Continued

”	” -2	Gyp-27	30.84	45.75	16.64	0.50	0.60	”	”
”	” -3	Gyp-28	32.25	45.85	16.51	trace	0.42	”	”
”	” -4	Gyp-29	31.54	45.68	17.04	trace	0.58	”	”
”	” -5	Gyp-30	31.54	45.50	16.33	0.50	0.62	”	”
”	” -6	Gyp-30D	30.84	45.93	16.37	0.50	0.56	”	”
Ishani	” -7	Gyp-31	31.54	45.50	16.59	0.50	0.54	”	”
”	” -8	Gyp-32	30.84	46.79	17.36	0.50	0.52	”	”
”	” -9	Gyp-33	32.25	46.19	16.69	trace	0.56	”	”
”	2357 -1	Gyp-34	32.25	46.28	19.37	trace	0.48	Hasham ul Haque, Senior Chemist	Azhar Khan, Superintendent Chemist
”	” -2	Gyp-35	32.25	46.16	19.48	trace	0.76	”	”
”	” -3	Gyp-36	31.54	45.84	18.21	0.51	0.16	”	”
Baghao	” -4	Gyp-37	32.25	46.15	19.27	1.01	0.64	”	”
”	” -5	Gyp-38	32.25	44.95	19.55	1.01	0.36	”	”
”	” -6	Gyp-39	31.54	45.56	19.27	0.51	0.16	”	”
”	” -7	Gyp-40	32.25	45.84	19.59	trace	0.40	”	”
Karher Buzdar	” -8	Gyp-42	32.25	46.56	19.66	trace	0.44	”	”
”	” -9	Gyp-42D	31.54	46.15	19.50	0.51	0.32	”	”
Gadumra	2355 -1	Gyp-51	31.89	46.03	18.06	trace	0.78	Azhar Khan, Superintendent Chemist	Shamsher Khan, Chief Chemist
”	” -2	Gyp-52	31.54	46.14	18.17	0.50	0.16	”	”
”	” -3	Gyp-53	31.54	46.20	18.67	0.50	0.20	”	”
”	” -4	Gyp-54	32.24	46.77	18.69	traces	0.46	”	”
Chang Mari	” -5	Gyp-55	31.89	46.03	18.17	”	0.46	”	”
”	” -6	Gyp-55D	31.89	46.30	18.19	”	0.44	”	”
”	” -7	Gyp-56	32.24	45.72	18.06	”	0.52	”	”
Kahan	2363 -1	Gyp-65	31.89	45.56	19.04	0.75	0.32	Azhar Khan, Superintendent Chemist	Shamsher Khan, Chief Chemist
”	” -2	Gyp-66	31.54	46.29	18.99	1.01	0.12	”	”
Safed	” -3	Gyp-67	32.24	45.28	18.04	traces	0.62	”	”
”	” -4	Gyp-68	32.24	45.52	19.41	”	0.16	”	”
”	” -5	Gyp-69	32.24	46.01	18.91	”	0.32	”	”
”	” -6	Gyp-70	32.24	47.12	19.26	”	0.26	”	”
”	” -7	Gyp-71	30.84	47.26	18.87	1.01	0.34	”	”
”	” -8	Gyp-72	31.54	46.27	19.03	0.50	0.18	”	”
”	” -9	Gyp-72D	31.54	46.26	18.99	0.50	0.20	”	”
”	” -10	Gyp-73	31.54	47.03	19.28	traces	0.16	”	”

Continued

”	2366 -1	Gyp-74	32.24	46.64	20.07	”	0.06	Ghulam Muhammad, Chemist	Azhar Khan, Superintendent Chemist
”	” -2	Gyp-75	32.24	46.13	19.58	”	0.06	”	”
Bala Dhaka	” -3	Gyp-76	30.84	46.30	19.22	0.50	0.10	”	”
”	” -4	Gyp-77	32.24	45.89	19.30	traces	0.04	”	”
Bahlol	” -5	Gyp-78	32.24	45.96	19.00	”	0.02	”	”
”	” -6	Gyp-79	31.61	46.47	19.12	”	0.20	”	”
”	” -7	Gyp-80	32.24	46.23	19.05	”	0.06	”	”
”	” -8	Gyp-81	32.24	46.30	19.00	”	0.04	”	”
”	” -9	Gyp-82	32.24	46.13	18.90	”	0.10	”	”
”	” -10	Gyp-83	32.24	46.40	19.10	”	0.04	”	”
”	” -11	Gyp-83D	32.24	46.47	19.00	”	0.04	”	”
”	2367 -1	Gyp-84	32.24	46.75	19.70	”	0.04	”	”
Chamalang	” -2	Gyp-85	31.61	45.65	19.00	”	0.40	”	”
”	” -3	Gyp-86	32.24	46.34	18.80	”	0.20	”	”
”	” -4	Gyp-87	31.61	46.34	18.80	”	0.04	”	”
”	” -5	Gyp-88	32.24	47.03	19.55	”	0.60	”	”
”	” -6	Gyp-88D	32.24	46.68	19.60	”	0.60	”	”
”	2362 -1	Gyp-89	31.40	38.62	17.13	1.61	0.70	Haider Kamal, Chemist	Azhar Khan, Superintendent Chemist
”	” -2	Gyp-90	32.53	46.65	19.56	traces	0.30	”	”
”	” -3	Gyp-91	32.53	46.65	19.52	”	0.60	”	”
”	” -4	Gyp-92	32.53	46.65	18.67	”	0.48	”	”
”	” -5	Gyp-93	31.40	44.52	19.33	”	0.40	”	”
”	” -6	Gyp-94	32.53	44.97	19.42	”	0.40	”	”
”	” -7	Gyp-95	32.53	41.43	17.94	0.80	1.30	”	”
”	” -8	Gyp-95D	32.53	41.84	17.96	0.80	1.28	”	”
”	2369 -1	Gyp-96	31.40	47.09	19.88	traces	0.86	Haider Kamal, Chemist	Azhar Khan, Superintendent Chemist
Girsini	” -2	Gyp-97	32.52	46.71	19.78	”	0.58	”	”
”	” -3	Gyp-98	31.40	39.45	16.88	”	3.80	”	”
Bohri Kohlu	” -4	Gyp-99	32.52	46.30	19.26	”	0.64	”	”
”	” -5	Gyp-100	32.52	46.70	19.62	”	0.36	”	”
”	” -6	Gyp-101	32.52	46.54	19.31	”	0.70	”	”
”	” -7	Gyp-102	31.40	46.90	18.60	”	0.96	”	”
”	” -8	Gyp102d	31.40	45.70	18.50	”	0.94	”	”
Mawand (west of road, North limb)	2364 -1	Gyp-103	32.25	45.84	19.65	”	0.14	Hasham-ul-Haque, Senior Chemist	Azhar Khan, Superintendent Chemist

Continued

”	” -2	Gyp-104	32.25	46.70	19.43	0.50	0.18	”	”
”	” -3	Gyp-105	32.25	46.36	19.77	0.50	0.28	”	”
Mawand (east of road, north limb)	” -4	Gyp-106	31.95	46.77	19.36	0.50	0.14	”	”
”	” -5	Gyp-107	31.95	45.64	19.85	0.50	0.08	”	”
”	” -6	Gyp-108	32.25	45.40	18.85	traces	0.10	”	”
”	” -7	Gyp-109	32.25	46.36	19.78	”	0.08	”	”
”	” -8	Gyp-110	32.25	46.66	19.50	0.50	0.24	”	”
”	” -9	Gyp-111	31.95	46.39	20.18	0.50	0.14	”	”
”	” -10	Gyp-112	32.25	45.60	19.60	traces	0.12	”	”
	” -11	Gyp112d	32.25	45.88	19.43	”	0.10	”	”
Nisau (south of Vitakri)	2361 -1	Gyp-113	30.84	46.96	19.33	<0.5	0.44	Zaheer Ali Khan, Chemist	Azhar Khan, Superintendent Chemist
”	” -2	Gyp-114	32.24	47.06	18.62	”	0.20	”	”
”	” -3	Gyp-115	30.80	46.11	19.47	”	0.22	”	”
”	” -4	Gyp-116	32.24	47.03	19.60	”	0.28	”	”
”	” -5	Gyp-117	32.24	47.54	19.30	”	0.64	”	”
”	” -6	Gyp-118	32.24	46.93	19.66	”	0.26	”	”
”	” -7	Gyp-119	31.54	47.20	19.57	”	0.32	”	”
”	” -8	Gyp119d	32.24	47.03	19.57	”	0.28	”	”
”	” -9	Gyp-120	32.24	47.07	19.49	”	0.34	”	”
”	” -10	Gyp-121	30.84	46.41	19.36	”	0.54	”	”
”	” -11	Gyp-122	31.54	47.17	19.37	”	0.22	”	”

Table 2. Complete analysis of Baska and Domanda gypsum samples taken from different localities of Balochistan and a few sample from Manjhail Kharar locality of Taunsa District, South Punjab. Chemical results received via report No.GSP/Chem/2001-2002/10 (Gyp-43 to Gyp-48D) and GSP/Chem/2001-2002/12 (Gyp-57 to Gyp-64D) dated October 25, 2001. Samples Gyp-43 to Gyp-48D were analyzed by Zaheer Ali Khan, Chemist, and approved by Azhar Khan, Superintending Chemist, received via report GSP/Chem/2001-2002/10, dated October 25, 2001. Samples Gyp-57 to Gyp-64D were analyzed by Azhar Khan, Superintending Chemist, and approved by Shamsher Khan, Chief Chemist, conveyed via report GSP/Chem/2001-2002/12, dated October 28, 2001.

Locality	Sender's No.	CaO%	SO_3%	H_2O^{+-}%	L.O.I.%	Insoluble Matter %	MgO%	Fe_2O_3%	Al_2O_3%	Na_2O ppm	K_2O ppm	Cl%
Karher Buzdar	Gyp-43	32.24	45.96	18.84	20.15	0.16	0.05	0.03	0.57	337	48	<0.02
”	Gyp-44	32.24	46.11	18.60	20.25	0.12	traces	traces	0.30	94	36	”
Kurcha	Gyp-45	32.24	46.07	18.99	20.87	0.10	0.08	traces	0.30	41	36	”
”	Gyp-46	32.24	44.32	18.25	21.13	0.50	0.27	0.58	0.22	216	48	”
”	Gyp-47	32.24	45.90	19.12	20.57	0.30	traces	traces	0.40	13	48	”
”	Gyp-48	32.24	45.01	18.72	20.11	1.50	traces	0.06	0.14	76	36	”
”	Gyp-48D	32.24	45.80	18.52	20.16	1.48	0.06	0.07	0.20	80	36	”
”	Gyp-49	23.83	38.93	15.88	21.70	4.30	traces	0.23	10.57	324	145	”

Continued

”	Gyp-50	28.04	45.69	19.03	20.86	0.16	0.33	0.04	4.80	94	36	”
Chang Mari	Gyp-57	31.89	46.71	18.87	20.74	0.50	traces	0.10	0.50	137	24	”
Kahan	Gyp-58	31.54	46.15	18.60	20.73	0.60	”	0.10	0.70	108	48	”
”	Gyp-59	31.54	39.14	16.08	22.29	4.06	1.51	0.47	1.43	270	121	”
”	Gyp-60	32.24	46.17	18.74	20.86	0.36	”	0.08	0.72	BDL	60	”
”	Gyp-61	31.89	46.50	19.09	20.85	0.26	”	0.03	0.57	41	BDL	”
”	Gyp-62	31.54	46.41	19.11	21.10	0.28	”	0.10	0.30	54	24	”
”	Gyp-63	32.24	45.75	19.24	21.83	0.20	”	0.07	0.23	14	72	”
”	Gyp-64	31.89	46.02	18.62	21.41	0.24	”	0.08	traces	BDL	48	”
”	Gyp-64D	31.89	46.10	18.69	21.38	0.26	”	0.08	”	”	48	”

Table 3. Chemical analyses of gypsum samples from Dera Bugti area of Balochistan. Chemical analyses Silica Sand and Ironstone of Loti anticline, Dera Bugti District, Balochistan Province, Pakistan. Samples MSM-SID-1 to -4 were chemically analyzed by Ghulam Muhammad, Chemist, approved by Azhar Khan, Chief Chemist, conveyed via Report No. GSP/Chem/2008-2009/07, dated November 7, 2008. Samples MSM-3/2007 to -7/2007 were analyzed by Haider Kamal, Senior Chemist, approved by Azhar Khan, Chief Chemist, conveyed via Reports GSP/Chem/2007-2008/14, dated February 29, 2008 and GSP/Chem/2007-2008/24, dated June 12, 2008.

Locality	Lab. No.	Sender's No.	CaO%	SrO%	SO_3%	$-H_2O$%	$+H_2O$%	L.O.I.%	Insoluble Matter %	SiO_2%	MgO%	Fe_2O_3%	Al_2O_3%	BaO%
Pirkoh (Dera Bugti) Domanda gypsum	2510-2	MSM-SID-2/ 2007	31.38	-	46.30	16.33	3.51	1.05	-	0.32	traces	traces	1.10	-
”	2510-5	MSM-SID-2/ 2007D	31.38	-	46.64	16.33	3.51	1.05	-	0.30	traces	traces	1.10	-
” dolomitic limestone of Domanda fm	2510-3	MSM-SID-3/ 2007	29.14	-	Traces	0.26	0.00	44.04	-	6.84	19.35	traces	0.30	-
Wadera Shero Sham Area (Dera Bugti) Baska gypsum	2493-1	MSM-3/2007	32.06	-	43.05	19.13	2.03	21.69	0.80	-	0.50	1.59	0.71	-
”	2493-3	MSM-3/2007D	31.98	-	42.96	19.15	2.00	21.61	0.88	-	0.50	1.59	0.75	-
”	2493-2	MSM-4/2007	31.65	-	41.02	19.60	0.64	21.55	3.22	-	0.50	1.19	0.21	-
Loti (Dera Bugti) Chitarwata Silica sand	2510-1	MSM-SID-1/ 2007	2.24	-	-	-	-	-	-	88.70	0.80	6.06	1.24	-
Loti (Dera Bugti) Chitarwata ironstone	2510-4	MSM-SID-4/ 2007	2.24	-	-	-	-	-	-	72.32	Traces	24.25	0.95	-
Sham (Dera Bugti) Baska celestite	2503-1	MSM-5/2007	1.12	38.50	42.96	-	-	-	-	-	-	-	-	7.63
”	2503-2	MSM-6/2007	1.12	39.21	42.64	-	-	-	-	-	-	-	-	7.99
” Shaheed Ghat shale aragonite + barite + celestite	2503-3	MSM-7/2007	41.40	0.51	1.83	-	-	-	-	-	-	-	-	11.80
” Shaheed Ghat shale aragonite + barite + celestite	2503-4	MSM-7/2007D	41.10	0.45	1.91	-	-	-	-	-	-	-	-	11.68

Gypsum deposits of Barkhan District, Balochistan

Lakha Kach (Rakhni) gypsum deposits host 6 beds (composite 19 - 20 m thick) with total 1 billion tons estimated reserves in 70 m thick Baska Formation. Chemical analyses of samples Gyp-7 to 18 (**Figure 3**) were shown in (**Table 1**). **Kodi More, Nodo, Ishani, Gadumra, Chang Mari and Baghao gypsum deposits** host 2 billion tons/bt gypsum deposits. **Kodi More deposits** host 6 gypsum beds (composite 19 m thick) in about 50 m Baska Formation. Chemical analyses of samples Gyp-19 to 24 (**Figure 3**) were shown in (**Table 1**). **Nodo deposits** host 6 gypsum beds (composite 15 m thick) in 48 m Baska Formation. Chemical analyses of samples Gyp-25 to 30 (**Figure 3**) were shown in (**Table 1**). **Ishani deposits** host 6 gypsum beds (composite 22 m thick) in about 50 m Baska Formation. Chemical analyses of samples Gyp-31 to 36 (**Figure 3**) were shown in (**Table 1**). **Baghao (Tumni) deposits** host 4 gypsum beds (6.5 m thick) in about 30 m Baska Formation. Chemical analyses of samples Gyp-37 to 40 (**Figure 3**) were shown in (**Table 1**). **Karcha (Khurcha) gypsum deposits** host 0.25 bt gypsum. It hosts 6 gypsum beds (composite 25 m thick) in about 78 m Baska Formation. Chemical analyses of samples Gyp-45 to 50 (**Figure 4**) were shown in (**Table 1**, **Table 2**). **Gadumra-Chang Mari deposits** host 3 gypsum beds (10 m thick) in about 30 m Baska Formation. Chemical analyses of samples Gyp-51 to 57 (**Figure 4**, **Figure 5**) shown in (**Table 1**, **Table 2**). **Bala Dhaka/Kali Chapri-Karher gypsum deposits** host 0.5 bt. It hosts 2 - 3 gypsum beds (3 - 7 m thick) in about 30 - 70 m Baska Formation. Chemical analyses of samples Gyp-41 to 44 and Gyp-76 to 77 (**Figures 3-5**) were shown in (**Table 1**, **Table 2**). **Bahlol gypsum deposits** host 0.5 bt. It hosts 7 gypsum beds (14 m thick) in 70 m Baska Formation. Chemical analyses of samples Gyp-78 to 84 (**Figure 4**) were shown in (**Table 1**).

Gypsum deposits of Kohlu District, Balochistan

Nisau (Vitakri)-Safed gypsum deposits host 3 bt gypsum. It hosts 8 - 9 gypsum beds (composite 25 - 27 m thick) in about 72 - 78 m Baska Formation. Chemical analyses of samples Gyp-67 to 75 and Gyp-113 to 122 (**Figure 4**, **Figure 5**) were shown in (**Table 1**). **Janthali gypsum deposits** host 0.25 bt gypsum. **Kahan-Khattan gypsum deposits** host 1 bt gypsum. It hosts 9 gypsum beds (composite 19 m thick) in about 60 m Baska Formation. Chemical analyses of samples Gyp-58 to 66 (**Figure 4**) were shown in (**Table 1**, **Table 2**). **Mawand gypsum deposits** host 1 bt gypsum. It hosts 3 - 7 gypsum beds (composite 16 - 17 m thick) in about 75 m Baska Formation. Chemical analyses of samples Gyp-103 to 112 (**Figure 5**) were shown in (**Table 1**). **Bohri Kohlu, Girsini and Lunda-Bahney Wali-Chamalang gypsum deposits** host 0.25 bt gypsum. It hosts 2 - 4 gypsum beds (5 m thick) in about 40 - 70 m Baska Formation. Chemical analyses of samples Gyp-85 to 102 (**Figure 4**, **Figure 5**) were shown in (**Table 1**).

Gypsum deposits of Sibi and Harnai Districts, Balochistan

Spintangi gypsum deposits show 16 mt [42] and are located 60 km NNW of Sibi town and accessible through a railway line from Sibi to Harnai.

Gypsum deposits of Dera Bugti District, Balochistan

Dera Bugti district hosts 1.75 bt of gypsum deposits at Pirkoh, Phailawagh-Giandari and Sham Wadera Shero area. One gypsum sample from Baska gypsum of Sham Wadera Shero Bugti area and 2 samples from Domanda shale of Pirkoh area were collected and analyzed (Table 3) along with other mineral samples.

Gypsum deposits of Musakhel District, Balochistan

Musakhel district host Chamoz-Khan Muhammad Kot 1 mt and Drug-Toi Nala-Savi Ragha-Zamray gypsum deposits host 2 bt gypsum reserves [47].

Gypsum deposits of Taunsa District, South Punjab

Manjhail gypsum deposit: The chemical analyses of samples Gyp-1 to 6 (Figure 3) were shown in (Table 1). The other deposits found from **Zindapir anticline** and **eastern limb** of Fort Munro-Sorra, Luni and Manka were mentioned in [17].

3.1.3. New Data on Early Cretaceous and Oligocene Iron Deposits from Sulaiman and Kirthar Foldbelts, Balochistan (Pakistan)

The Early Cretaceous Johan-Dilband and Khad Kucha ironstones (Figure 1) were primarily discovered by present author (M. Sadiq Malkani) and Masud Tariq in 1990 during geological mapping and mineral exploration program ([54], pages 1077-1079), [55]. This ironstone is found in lower part of Sembar Shale, recently named as Dilband Formation [56]. According to initial chemical analyses the Fe_2O_3 is varied from 24.79% to 69.75% (Table 4) of Johan-Dilband iron deposits while Khad Kucha ironstone show low grade Fe_2O_3 24.79% (Table 4). Later on detail survey were carried out by Akhtar Kakepoto and Mian Hassan Ahmad. Further Akhtar Kakepoto and M. Sadiq Malkani also worked on Johan-Dilband ironstones and their extension which resulted the total reserve estimated about 340 million tons including 200 mt proved [56], and remaining about 140 mt indicated/inferred reserves ([54], pages 1077-1079]), [56]. These ironstone thin lense of less than a meter were found in Coalpur and Murdar

Table 4. 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 Geological mapping and mineral investigation project. These samples were chemically analyzed by Allah Bukhsh, Chemist, approved by Mushtaq Hussain, Chief Chemist, conveyed via Chemical analysis Report No. Chem (91-92) 10 dated January 16, 1991. This table is modified after [54].

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

Ghar (Kachi and Quetta Districts), Gaz and Zahri Range near Nur Gama (Khuzdar District), and Khad Kucha (Mastung District) areas ([54], pages 1077-1079). The Morov river area (Kalat District) may host largely covered iron deposits. Further detail can be seen in ([54], pages 1077-1079).

The Oligocene ironstone (**Table 3**) exists both in Chitarwata of Sulaiman foldbelt and Nari Formation of Kirthar foldbelt. Chitarwata iron is found more than 1 m thick in Zin (high quality) and surrounding areas of Taunsa District. It is exposed just on the sides of Taunsa-Barthi road. This road may be extended to Rara Sham area of Kingri (Musakhel, Balochistan). Zin area iron deposit (near Barthi, Koh Sulaiman Tehsil, Taunsa District) is small but seems to be extensive. It extends (but not thick) northward to Chitarwata area of Taunsa District, southward to Dera Ghazi Khan and Rajan Pur, Dera Bugti, Kohlu, Sibi and Kachi districts. This Chitarwata Formation iron (**Figure 1**) is found with silica sand in Loti anticline area of Dera Bugti. It is exposed just on the sides of Dera Bugti-Kashmor road. Its chemical analysis show as low grade iron Fe_2O_3 24.25% (**Table 3**). Other impurities are SiO_2 72.32%, CaO 2.24%, Al_2O_3 0.95% and MgO in traces. Dera Bugti iron deposit seems to be small but extensive. The ironstone in Nari Formation is exposed in the Sor Range anticlinal area and extends further south ward Kirthar foldbelt. Nari occurs in both eastern Kirthar (such as Sehwan and other areas) and western Kirthar (Karkh and Moola Zahria and other areas) foldbelts. In this way the large reserves of low grade ironstone of Chitarwata Formation in Sulaiman foldbelt and in Nari Formation of Kirthar foldbelts is expected. Other iron ore deposits of Pakistan can be seen in [6] [7] [8] [55].

3.1.4. New Data on Silica Sand Deposits from Sulaiman Foldbelt, Balochistan (Pakistan)

Dera Bugti silica sand deposits in the lower part of Vihowa group in the vicinity of Dera Bugti town and also just close to Dera Bugti Sui road in the Loti anticline were reported preliminary by [10]. Loti and other Dera Bugti silica sand deposits (**Figure 1**) are found in Oligocene Chitarwata Formation located in the central and southern part of Dera Bugti district area. The silica sand is low quality but have thick and large reserves. Here some description, chemical analyses (**Table 3**) and reserve estimation are being mentioned. Loti low grade quartzose silica sand shows 80.70% SiO_2 (**Table 3**). The Loti silica sand beds are more than 20 m thick. Its hardness is soft. This silica sand extends into Koh Sulaiman foot mountain areas of Rajanpur, Dera Ghazi Khan and Taunsa districts of South Punjab. On other side it extends into Sibi trough. From Sibi trough to Kirthar basin a strong variation occurs. In Sulaiman basin Chitarwata is terrestrial while its coeval in Kirthar basin Nari and Gaj Formations are marine. In this way expecting encouraging reserves (more than 1 billion tons) of low grade silica sand deposits of Chitarwata Formation and other terrestrial Vihowa, Litra and Chaudhwan formations. Other silica sand deposits of Pakistan can be seen in [6] [7] [8]. This silica sand and terrestrial Vihowa Group (Oligocene to Pliocene) strata may explore uranium because of encouraging results from Vihowa Group of Dera Ghazi Khan and Taunsa Districts of South Punjab.

3.2. Geochemical (Stream Sediments) Exploration of Mekhtar, Tor Thana, Sehan, Lakhi and Anambar areas (Toposheets 39F/3 and 39F/7) of Loralai District, Balochistan Province (Pakistan)

Geochemical exploration was done with Australian experts in northern Makran and Siahan Ranges for gold but not promising results, and only gold is associated with antimony veins [21]. Here Geochemical exploration of said area were carried out by author (M. Sadiq Malkani) and Masud Tariq geologist during the geological mapping and mineral investigation, due to finding of Barite [50], fluorite-calcite veinings [51] [52] [53] and some red ferruginous zones and also finding of some base metals in the synchron rocks of Khuzdar and Lasbela Districts of Balochistan. Here geochemical explorations based on stream sediments including heavy mineral concentrates/HMC (**Table 5**) (panning in water), fine stream sediments sampling (**Table 6**) from panning localities, and randomly few rocks and mineral samples were collected (**Table 7**). The chemical analyses of these samples show some anomalous elements as shown in (**Tables 5-7**) and also described below. The resistant minerals can be detected by HMC, while fine sediments can detect mobile element. Gold Au is anomalous in HMC of Chur (6.3 ppm), Dargai Dabrai (4.6 ppm), Zerulum (1.6 ppm) and Lakhi (1.4 ppm) (**Table 5**). Gold Au is anomalous in fine sediments of Lehri Kama Derlun (0.04 ppm), Gar Lakhi junction (0.03 ppm), and Wadan and Zerulum (0.02 ppp) (**Table 6**). Gold is not anomalous in any rock and mineral samples (**Table 7**). Silver Ag is anomalous in HMC of Zhopi Tangi (10 ppm), Zerulum (7 ppm), Dargai Dabrai,

Table 5. Geochemical exploration (Heavy Mineral Concentrate/HMC in stream sediment) sampling and their chemical analyses and anomalous values) of Mekhtar, Tor Thana, Kotkai, Lakhi, Sehan and Anambar areas of Loralai District, Balochistan. These samples were chemically analyzed by Imtiaz Ali, Chemist, approved by Shamsher Khan, Chief Chemist, conveyed via Report No. GSP/Chem/98-99/02 dated August 28, 1998.

Stream	Grid Reference	Sample No.	Cu ppm	Pb ppm	Zn ppm	Ni ppm	Co ppm	Mn ppm	Ag ppm	Au ppm
Lakhi	491386	MTS-SS (H)-1	30	40	50	57	20	933	2	BDL
Wadan	489384	” -2	46	71	71	100	26	677	2	0.10
Lakhi	468390	” -3	33	41	68	69	20	842	5	1.2
Darwazai	494405	” -4	27	21	32	25	10	816	2	BDL
Gar	491407	” -5	36	41	73	50	19	729	2	”
GarLakhi jn	470393	” -6	71	54	64	80	21	878	2	”
Zhopi Tangi	451381	” -7	80	98	90	251	45	808	10	0.1
Shne Zawar	436376	” -8	89	103	92	251	45	1959	4	BDL
Adaga	433384	” -9	35	45	51	52	19	357	2	”
Shureela	470378	” -10	75	79	78	198	40	1091	5	”
Shureela	470378	” -10D	76	81	81	191	42	1111	5	”

Continued

Dargai Dabrai	362359	” -11	47	62	68	97	24	962	5	4.1
Zerulun	371370	” -12	38	57	46	48	19	888	7	1.6
Loe Derlun	362370	” -13	39	53	50	50	19	431	2	0.1
Lehri Kama Derlun	325354	” -14	37	60	45	42	19	431	2	0.1
Lakhi	324350	” -15	37	73	60	116	28	986	4	BDL
Sheplu south	320392	” -16	33	51	30	31	16	367	2	”
Chur	353482	” -17	55	42	34	34	13	140	4	6.3
Sheplu north	351480	” -18	13	45	17	14	11	58	3	0.1
Chichlu	533578	” -19	31	48	33	29	15	253	2	0.1
Sande north	338576	” -20	87	67	67	50	18	216	3	0.1
Sande north	338576	” -20D	86	65	68	52	17	286	3	0.1
Sehan	312574	” -21	50	41	23	26	12	392	2	BDL
Shne Zawar	364586	” -22	69	54	47	38	16	219	5	”
Buzrg Sherwan	314552	” -23	44	61	41	41	15	97	3	”
Mekhtar Kar north	429561	” -24	55	51	37	35	16	178	3	”
Mekhtar Kar south	440553	” -25	89	65	56	53	17	175	3	0.1
Lakhi	247303	” -31	41	71	57	81	26	948	BDL	0.1
Tirkha Khuram	248300	” -32	86	129	74	178	45	389	”	BDL
Luni Talao Daman	223313	” -33	10	48	11	9	11	90	”	”
Lakhi	182294	” -34	35	70	50	66	22	680	”	”
Anambar south	124337	” -35	28	60	21	37	14	107	”	”
Anambar southeast corner	071298	” -36	36	58	46	46	18	145	”	”
Aghbergi	085333	” -37	34	62	40	40	17	283	1	”
Anambar north	077424	” -38	20	59	26	29	14	86	BDL	”
Sehan Rud	083426	” -39	18	49	15	12	11	137	”	”
Shirin Kach west	111460	” -40	25	56	15	73	16	178	”	”
Shirin Kach west	111460	” -40D	24	58	19	74	17	183	”	”
Shirin Kach east	119476	” -41	8	50	96	4	10	95	”	”
Watgam mozai	123473	” -42	21	63	26	22	14	47	”	”
Sihan rud	131471	” -43	31	58	19	21	14	173	5	”
Kot Bai west	141492	” -44	70	79	45	48	18	180	BDL	”
Kot Bai east	161514	” -45	45	72	65	28	15	92	”	”
Chamuz	172523	” -46	107	105	69	69	21	104	”	”
Tor Indi	176523	” -47	51	85	46	41	17	45	”	”
Sehan Rud	178519	” -48	33	59	19	23	12	182	”	”
Sehan Rud	285551	” -49	52	65	32	44	16	236	”	”
Nigang	278557	” -49D	54	68	31	45	15	240	”	”

Table 6. Geochemical exploration (fine -80 mesh stream sediment sampling and their chemical analyses and anomalous values) of Mekhtar, Tor Thana, Kotkai, Lakhi, Sehan and Anambar areas (Toposheets 39 F/3, 7) of Loralai District, Balochistan. First 22 Samples were chemically analyzed by Hesham-Ul-Haque, Senior Chemist, approved by Shamsher Khan, Chief Chemist, conveyed via Report No. GSP/Chem/95-96/10, dated September 17, 1995. Last 27 Samples were chemically analyzed by Haider Kamal, Chemist, approved by Shamsher Khan, Chief Chemist, conveyed via Report No. GSP/Chem/95-96/11, dated September 26, 1995.

Stream	Grid Reference	Sample No.	Cu ppm	Pb ppm	Zn ppm	Ni ppm	Co ppm	Mn ppm	Cd ppm	Ag ppm	Au ppm
Lakhi	491386	MTS-SS (F)-1	18	120	44	63	29	907	<2	<2	BDL
Wadan	489384	” -2	23	135	42	62	33	661	”	”	0.02
Lakhi	468390	” -3	30	125	44	66	32	846	”	”	BDL
Darwazai	494405	” -4	22	140	63	81	37	1371	”	”	”
Gar	491407	” -5	35	138	52	72	36	1258	BDL	”	”
Gar Lakhi jn	470393	” -6	29	140	53	75	39	1356	2	”	0.03
Zhopi Tangi	451381	” -7	35	170	52	85	40	964	<2	2	BDL
Shne Zawar	436376	” -8	31	135	40	82	37	731	”	3	”
Adaga	433384	” -9	32	124	45	76	37	614	”	<2	”
Shureela	470378	” -10	15	125	56	77	44	1190	”	<2	”
Shureela	470378	” -10D	14	127	58	78	45	1185	<2	<2	”
Dargai Dabrai	362359	” -11	23	121	50	75	40	1363	”	4	”
Zerulun	371370	” -12	32	100	53	65	35	864	”	BDL	0.02
Loe Derlun	362370	” -13	22	88	44	56	34	878	2	”	BDL
Lehri Kama Derlun	325354	” -14	39	82	42	52	33	1278	”	”	0.04
Lakhi	324350	” -15	40	110	49	67	37	1178	<2	<2	BDL
Sheplu south	320392	” -16	40	7	41	53	31	774	4	”	”
Chur	353482	” -17	52	92	58	63	26	601	4	”	”
Sheplu north	351480	” -18	38	BDL	29	56	27	418	5	”	”
Chichlu	533578	” -19	47	91	54	62	31	694	2	”	”
Sande north	338576	” -20	40	90	56	48	25	400	2	”	”
Sande north	338576	” -20D	38	91	58	49	26	402	2	<2	”
Sehan	312574	” -21	20	65	57	37	22	1140	3	BDL	”
Shne Zawar	364586	” -22	21	90	64	47	24	500	3	”	”
Buzrg Sherwan	314552	” -23	20	60	38	49	23	460	5	”	”
Mekhtar Kar north	429561	” -24	30	62	54	48	25	658	5	<2	”
Mekhtar Kar south	440553	” -25	27	80	75	51	22	538	5	<2	”
Lakhi	247303	” -31	32	88	34	54	30	2911	3	2	”
Tirkha Khuram	248300	” -32	53	105	51	54	37	985	2	BDL	”
Luni Talao Daman	223313	” -33	39	70	31	47	22	520	5	”	”
Lakhi	182294	” -34	38	125	53	64	40	1660	2	”	”
Anambar south	124337	” -35	27	50	31	38	21	645	5	”	”
Anambar southeast corner	071298	” -36	37	65	32	41	28	590	5	”	”

Continued

Anambar southeast corner	071298	” -36D	39	63	31	41	29	583	5	”	”
Aghbergi	085333	” -37	157	68	29	53	23	411	5	”	”
Anambar north	077424	” -38	72	65	29	57	24	438	6	2	”
Sehan Rud	083426	” -39	42	42	34	37	20	775	4	<2	”
Shirin Kach west	111460	” -40	57	67	30	54	23	605	5	<2	”
Shirin Kach east	119476	” -41	45	50	26	43	21	328	6	BDL	”
Watgam mozai	123473	” -42	37	67	37	61	27	508	6	”	”
Sehan Rud	131471	” -43	56	45	30	49	24	648	7	”	”
Kot Bai west	141492	” -44	21	78	47	51	24	606	2	”	”
Kot Bai east	161514	” -45	41	60	40	55	23	490	4	”	”
Chamuz	172523	” -46	30	75	47	52	23	465	4	”	”
Chamuz	172523	” -46D	32	76	45	51	24	460	4	”	”
Tor Indi	176523	” -47	33	58	35	55	23	457	5	<2	”
Sehan Rud	178519	” -48	50	56	44	50	27	916	6	<2	”
Sehan Rud	285551	” -49	33	48	56	40	24	1150	4	2	”
Nigang	278557	” -50	47	49	46	52	33	650	7	BDL	”

Table 7. Geochemical exploration (rocks and minerals sampling and their chemical analyses and anomalous values) of Mekhtar, Tor Thana, Kotkai, Lakhi, Sehan and Anambar areas (Toposheets 39 F/3 and 39F/7) of Loralai District, Balochistan. First 15 samples were chemically analyzed by Hesham-Ul-Haque, Senior Chemist, approved by Shamsher Khan, Chief Chemist, conveyed via Report No. GSP/Chem/95-96/12 dated October 17, 1995. Last 16 samples were chemically analyzed by Ghulam Muhammad, Chemist, approved by Shamsher Khan, Chief Chemist, conveyed via Report No. GSP/Chem/95-96/13 dated October 17, 1995.

Grid Reference	Toposheet No.	Remarks	Sample No.	Cu ppm	Pb ppm	Zn ppm	Ni ppm	Co ppm	Mn ppm	Cd ppm	Ag ppm	Au ppm
-	39F/3	Watgam anticline (Fluorite veins in Loralai lst)	MTS-3	54	90	22	36	23	255	4	<2	BDL
138540	39F/3	Red brown coloured zone in Sembar	” -4	27	370	147	21	7	123	BDL	”	”
440585	39F/7	Siderite nodule in Loralai lst	” -5	59	313	68	156	53	716	3	”	”
075320	39F/3	Red brown coloured zone in south west	” -6	58	103	26	47	40	1831	4	”	”
-	39B/15	Hot water-sulphur spring Mahiwal	” -9	65	226	27	46	27	198	4	2	”
433588	39F/7	Mekhtar sandstone	” -13	27	380	60	56	26	1523	<2	2	”
513364	39F/7	Igneous complex wadan Tangi	” -14	26	278	58	113	57	532	BDL	<2	”
-	39F/7	Coquina bed	” -16	44	132	43	63	26	2124	2	<2	”
988378	39F/7	barite	” -17	12	233	13	8	9	183	BDL	2	”

Continued

488376	39F/7	Phosphatic? bed upto 1 m	” -18	55	230	16	49	26	738	4	2	”
488376	39F/7	”	” -18D	57	235	16	47	27	727	5	2	”
465384	39F/7	”	” -19	55	245	46	107	40	1973	4	<2	”
490563	39F/7	Calcite and fluorite	” -20	62	63	17	31	30	476	6	<2	”
-	39F/7	Barite	” -25	12	77	32	10	10	153	BDL	<2	”
Chichlu	39F/7	Pab sandstone	” -26	29	130	24	28	21	2462	<2	<2	”
373576	39F/7	Volcanics?	” -27	53	335	29	55	40	1973	2	<2	”
-	39F/3	Iron in north of Tor thana village	” -28	48	157	23	44	48	2871	2	<2	”
-	39F/3	Siderite nodule in Sembar	” -29	99	347	53	939	96	275	4	2	”
-	39F/3	Lead? in sembar	” -32	48	76	24	37	22	85	4	<2	”
-	39F/7	-	” -34	51	105	42	104	35	803	2	<2	”
-	39F/7	barite	” -35	10	219	14	12	9	80	BDL	3	”
-	39F/7	barite	” -35D	12	255	12	11	9	84	BDL	<2	”
540427	39F/7	Igneous and qtz in Narwal	” -37	29	190	34	40	37	8768	3	<2	”
-	39F/7	Iron	” -38	49	355	20	84	42	8000	2	2	”
140313	39F/3	Redish brown	” -39	60	128	23	34	28	346	4	2	”
-	39F/3	-	” -40	67	77	13	33	30	121	5	<2	”
-	-	-	” -41	45	261	26	95	42	3791	6	<2	”
-	-	-	” -42	36	382	62	53	31	1350	4	<2	”
-	-	-	” -43	56	90	16	38	28	284	2	<2	”
-	-	-	” -44	39	198	44	83	44	1379	5	<2	”
-	-	-	” -45	38	109	26	37	29	474	2	3	”

Sehan, Shne Zawar and Shureela (5 ppm), and Chur and Lakhi (4 ppm) (Table 5). Silver Ag is anomalous in fine sediments of Dargai Dabrai (4 ppm) and Shne Zawar (3 ppm) (Table 6). Silver Ag is anomalous in reddish ferruginous zone/ area (3 ppm) in rock and mineral sample (Table 7). Copper Cu is anomalous in HMC of Chamuz (107 ppm), Mekhtar Kar (89 ppm), Sande North (87 ppm), Shne Zawar (89 ppm) and Zhopi Tangi (80 ppm) (Table 5). Copper Cu is anomalous in fine sediments of Aghbergi (157 ppm) and Anambar north (72 ppm) ((Table 6). Lead Pb is anomalous in HMC of Zhopi Tangi (98? ppm), Shne Zawar (103 ppm), Chamuz (105 ppm) and Tirkha Khuram (129 ppp) (Table 5). Lead Pb is anomalous in fine sediments of Zhopi Tangi (170 ppm), Shne Zawar (124 ppm), Shureela (127 ppm), Lakhi (110, 120, 125, 125), Wadan (135 ppm), Darwazai (140 ppm), Gar (138 ppm), Gar Lakhi jn (140 ppm) and Tirkha Khuram (105 ppp) (Table 6). Zinc is anomalous (147 ppm) in a sample taken from red zone of Sembar Formation (Table 7). Cobalt Co is anomalous in HMC of Zhopi Tangi (45 ppm), Shne Zawar (45 ppm) and Shureela (42 ppm) (Table 5). Cobalt Co is anomalous in fine sediments of Shureela (45 ppm), Dargai Dabrai (40 ppm) and Zhopi Tangi (40 ppm) (Table 6). Nickle is anomalous in HMC in Tirkha Khuram (178 ppm), Lakhi (116 ppm), Shureela (198 ppm), Zhopi Tangi and Shne Zawar (251 ppm) and Wadan (100 ppm) (Table 5). Manganese Mn is anomalous in HMC of Shne Zawar (1959 ppm) and Shureela (1111 ppm) (Table 5). Manganese Mn is anomalous in fine sediments of Sehan (1140, 1150 ppm), Lakhi (1660, 2911 ppm), Lahri Kama Darlun (1278 ppm), Dargai Dabrai (1363 ppm), Shureela (1190 ppm), Gar (1258ppm) and Gar Lakhi junction (1356 ppm) (Table 6).

3.3. Revision of 25 Years History of Dinosaur Discoveries from Pakistan

From Pakistan the information about dinosaurs was started recently just after the first dinosaur discovery made by M. Sadiq Malkani in 2000 [65]. Brief history of dinosaur bone discoveries are mentioned in the introduction section. Executive summary of 14 titanosaurian sauropods (Figures 6-22) including one new titanosaur (Tables 8-11), and 3 theropod (Figures 23-25) dinosaurs are being presented. Beside these dinosaurs, their terrestrial communities and ecosystem discovered from the terrestrial latest Maastrichtian (67 - 66 Ma) Vitakri Formation (pages 903 to 906 of [17]), [73] [75] [88] [89] of Sulaiman foldbelt (middle Indus) represented by mesoeucrocodiles (*Pabwehshi pakistanensis* [98], *Induszalim bala* [88], *Sulaimanisuchus kinwai* [9] [88] and *Mithasaraikistan ikniazi* [88]), pterosaurs (*Saraikisaurus minhui* [78] [88] and *Imrankhanuqab qaeddiljani* [17]), snake (*Wadanaang kohsulaimani* [88]), bird (*Wasaibpanchi damani* [88] [89]), and mammals (*Mirvitakriharan haji* [89] and *Khansultan masoomrashidi* new genus and new species, see below). Many other bone fossils, and footprints and trackways were also discovered from different basins

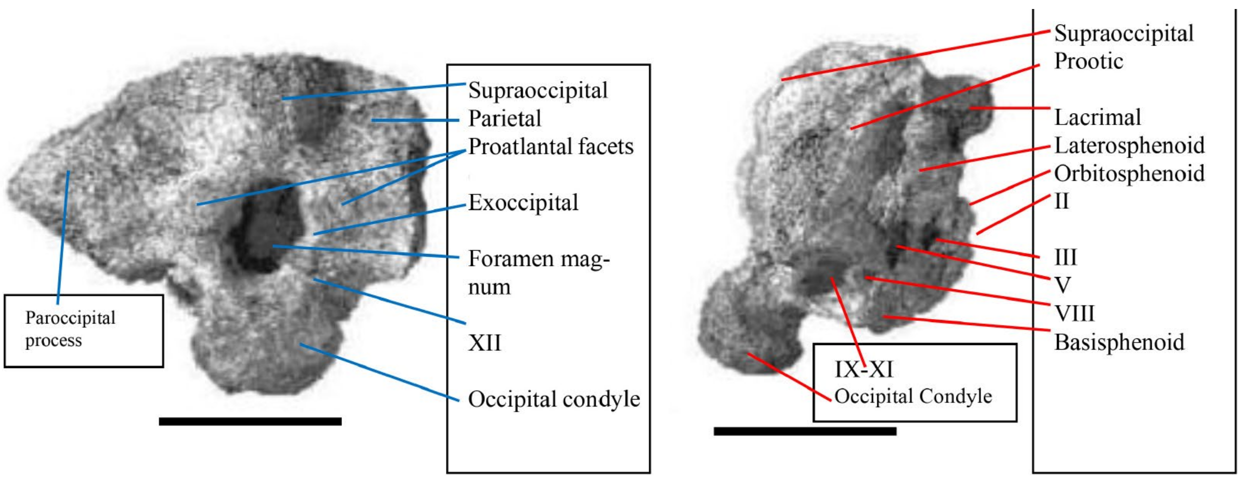

Figure 6. *Imrankhanshaheen masoombushrai* new genus and new species holotypic Braincase (GSP/MSM-2-16; GSP-UM 7000) in posterior and right lateral views, found from type locality Top Kinwa (Figure 4 of [88]), Barkhan District, Balochistan Province, Pakistan. Scale, black bar is 5 cm.

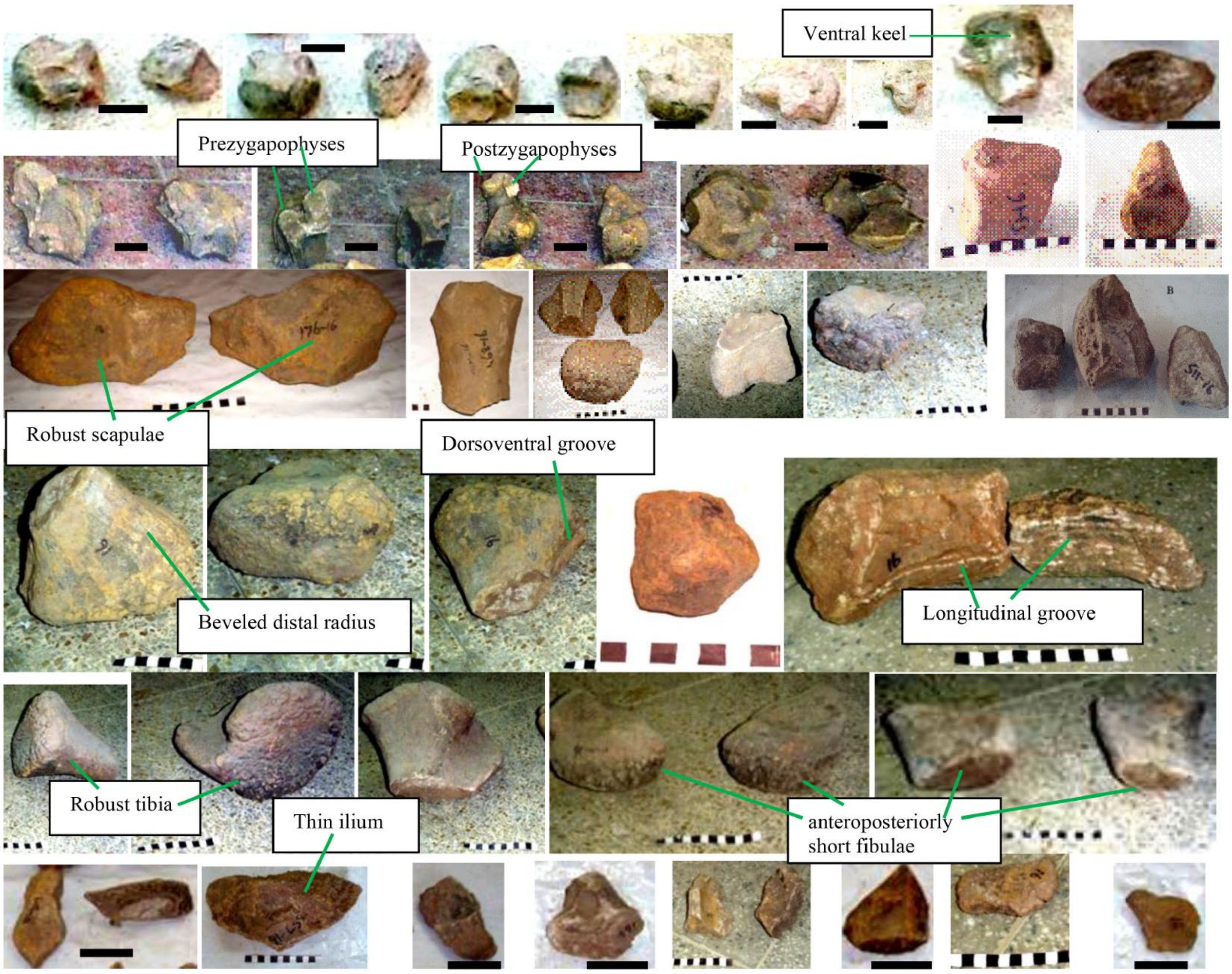

Figure 7. *Imrankhanshaheen masoombushrai* new genus and new species holotype (rows 1 - 6) from type locality Top Kinwa (Figure 4 of [88]), Barkhan District, Balochistan Province, Pakistan. **Row 1**, cervical and dorsal vertebrae GSP/MSM-131-16 and GSP/MSM-132-16 in 3 views; two coosified sacral vertebrae with partial rib GSP/MSM-137-16 in 4 views; two coosified sacral vertebrae GSP/MSM-776-16. **Row 2**, anterior and mid caudal vertebrae GSP/MSM-34-16 and GSP/MSM-35-16 in 4 views; distal caudal vertebra GSP/MSM-153-16 in 2 views. **Row 3**, left and right proximal scapulae GSP/MSM-250-16, GSP/MSM-176-16; mid humerus GSP/MSM-468-16; left and right proximal ulna GSP/MSM-175-16 and GSP/MSM-240-16 (upper), distal ulna GSP/MSM-74-16 (lower); distal ulna GSP/MSM-74-16 in 2 views; anterior dorsal vertebra GSP/MSM-256-16; mid-posterior dorsal vertebrae with ventral ridge GSP/MSM-774-16 and GSP/MSM-511-16. **Row 4**, distal radius GSP/MSM-160-16 in 3 views; metacarpal GSP/MSM-1036-16; acetabulum in 2 pieces GSP/MSM-147-16 and GSP/MSM-148-16. **Row 5**, proximal right tibia biconvex lense shaped GSP/MSM-73-16 in 3 views; left and right proximal fibulae GSP/MSM-76-16 and GSP/MSM-77-16 in 2 views. **Row 6**, photo 1 (p1), convex part of sternal GSP/MSM-1014-16, sternal part GSP/MSM-604-16; p2, part of ilium GSP/MSM-557-16, p3, neural spine or osteodermal spine with wound mark GSP/MSM-150-16, p4, neural arch/neural spine GSP/MSM-391-16; p5, cervical ribs GSP/MSM-328-16, GSP/MSM-329-16; p6, distal neural spine GSP/MSM-767-16; p7, 8, mosaic type osteoderms GSP/MSM-83-16, GSP/MSM-1035-16. Scale each black or white digit is 1cm. Black scale bar is 5 cm drawn tentatively from photos/plates found in [70] [71] [74].

of Pakistan mentioned as below. Recently fifty seven discovered biotas from Paleozoic, Mesozoic and Cenozoic of Pakistan include 3 fishes (Table 10 of [17]), 35 reptiles including 1 titanosauriform (Table 2 of [17]), 14 titanosaurs (**Tables 8-11**), 3 theropods (Table 5 of [17]), 1 snake (Table 7 of [17]), 2 pterosaurs (Table 7 of [17]), 7 crocodiles (Tables 6 & 7 of [17]) and 7 ichnotaxa (Table 12 of

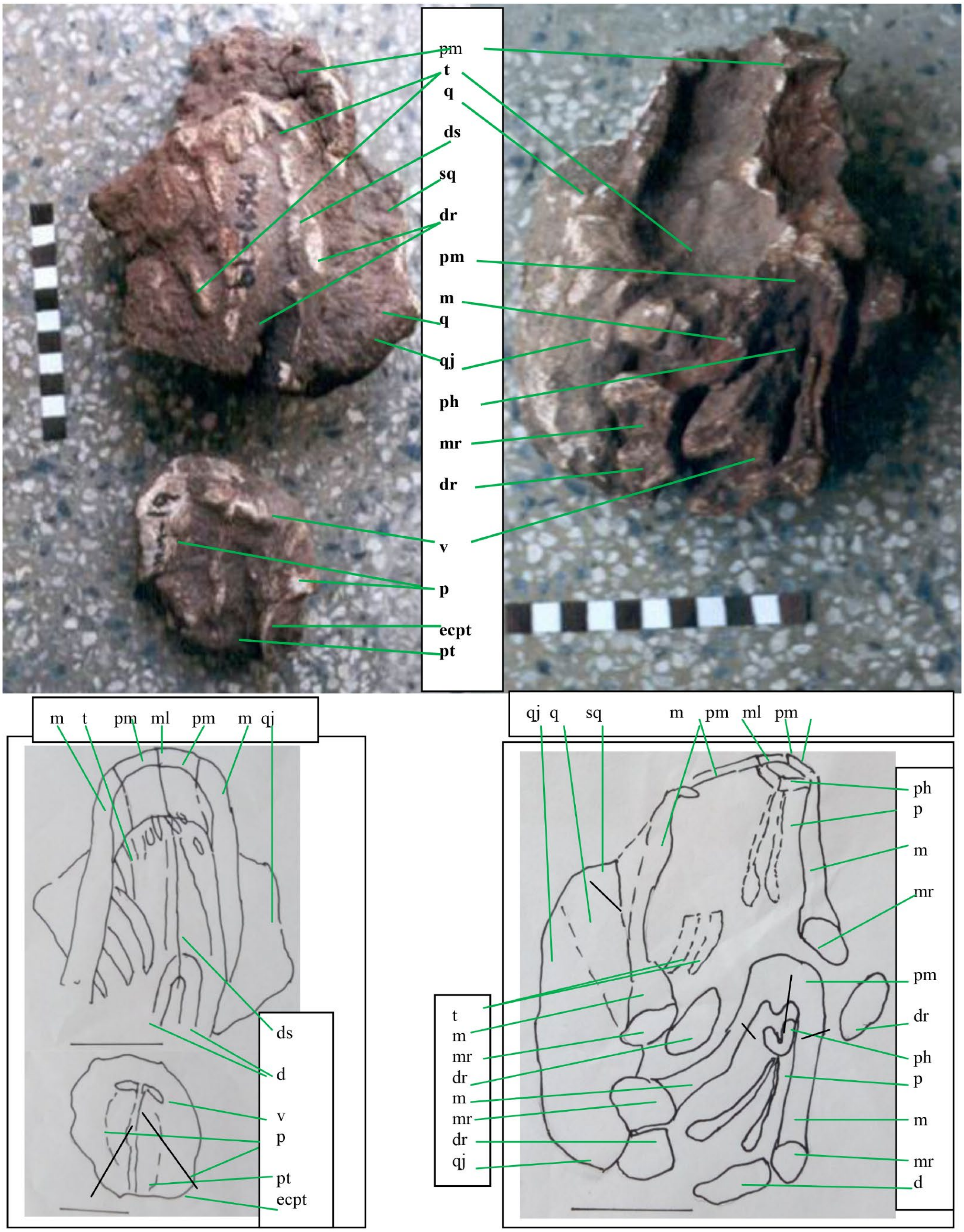

Figure 8. Images and line drawings of *Gspsaurus pakistani* [88] holotypic skull GSP/MSM-79-19 and GSP/MSM-80-19 in ventral and posterior cross sectional views. Scale, each black/white digit is 1 cm. Scale bar in line drawing represents 5 cm. Abbreviations: d, dentary; dr, dentary ramus; ds, dentary symphysis; ecpt, ectopterygoid; ml, midline contact; m, maxilla; mr, maxillary ramus; p, palatine; ph, palatal dorsal hook; pt, pterygoid; q, quadrate; gj, quadratojugal; sq, squamosal; t, teeth; v, vomerine.

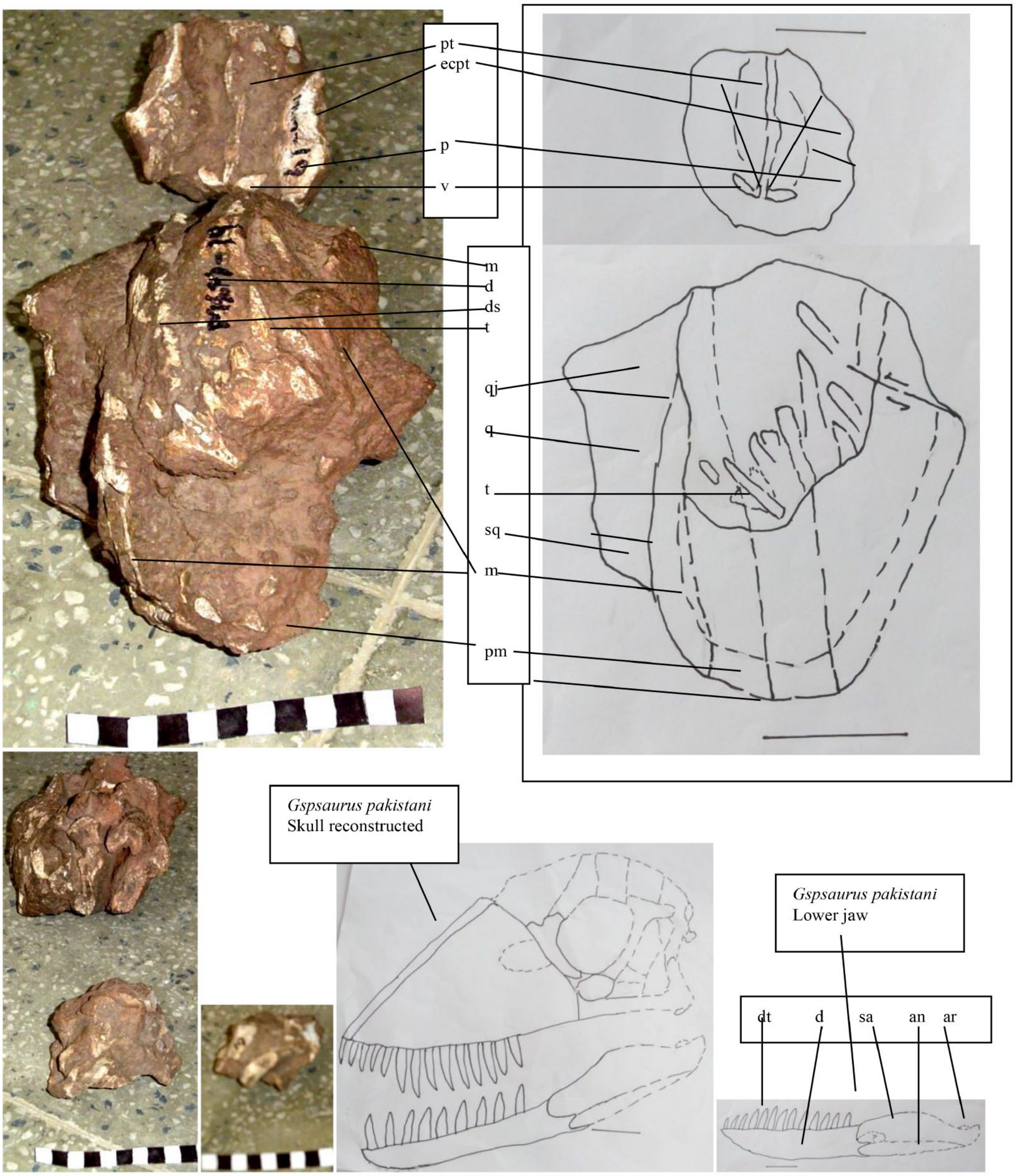

Figure 9. Photograph and line drawing of *Gspsaurus pakistani* [88] holotypic skulls GSP/MSM-79-19 (larger specimen) and GSP/MSM-80-19 (smaller specimen) found from Alam locality, in ventral view. Skull and mandible reconstruction after fossils and estimation. Scale in image, each black or white digit is 1 cm. Scale bar in line drawing represents 5 cm. Abbreviations: d, dentary; dr, dentary ramus; ds, dentary symphysis; ecpt, ectopterygoid; ml,midline contact; m, maxilla; mr, maxillary ramus; p, palatine; ph, palatal dorsal hook; pt, pterygoid; q, quadrate; gj, quadratojugal; sq, squamosal; t, teeth; v, vomerine.

[17]), 10 mammals (Tables 8 & 9 of [17]), 1 bird (Table 10 of [17]), 7 invertebrates (Table 11 of [17]) and 1 plant (Table 10 of [17]). Besides bone fossils,

Figure 10. *Gspsaurus pakistani* [88] holotypic postcrania. **Row 1**, p1, anterior caudal vertebra (or braincase) GSP/MSM-62-19 in anterior view; p2, 3, 4, subrow 1, cervical vertebrae GSP/MSM-107-19, GSP/MSM-108-19, GSP/GSP/MSM-109-19; subrow 2, dorsal vertebrae GSP/MSM-110-19, GSP/MSM-111-19, GSP/MSM-112-19; subrow 3, caudal vertebrae GSP/MSM-113-19, GSP/MSM-114-19, GSP/MSM-115-19, GSP/MSM-116-19, GSP/MSM-117-19 in lateral, anterior and posterior views. **Row 2**, p1, subrow 1, cervical vertebrae GSP/MSM-437-19, GSP/MSM-220-19, GSP/MSM-502-19; subrow 2, dorsal vertebra GSP/MSM-617-19, partial ilium GSP/MSM-216-19; p2, subrow 1, proximal radius GSP/MSM-215-19; proximal left tibia GSP/MSM-119-19; proximal left femur GSP/MSM-213-19; subrow 2, distal left tibia GSP/MSM-569-19; distal right tibia GSP/MSM-710-19; distal left femur GSP/MSM-118-19. **Row 3**, p1, 2, proximal left tibia GSP/MSM-119-19; p3, 4, distal right tibia GSP/MSM-710-19 and distal left femur GSP/MSM-118-19 in 2 views; p5, transversely elongated oval shaped right distal tibia GSP/MSM-710-19 in ventral view; **Row 4**, p1, left and right partial proximal scapula GSP/MSM-1100-19, GSP/MSM-217-19; p2, subrow 1, anterior caudal vertebrae GSP/MSM-219-19, GSP/MSM-218-19; posterior caudal GSP/MSM-221-19; subrow 2, partial distal right scapula GSP/MSM-217-19; caudal vertebrae GSP/MSM-696-19, GSP/MSM-777-19; p3, anterior caudal vertebrae GSP/MSM-219-19 and GSP/MSM-218-19, mid caudals GSP/MSM-696-19 and GSP/MSM-777-19, posterior caudal GSP/MSM-221-19; p4, 5, 6, neural arch GSP/MSM-146-19 in 3 views; p7, postzygapophyses GSP/MSM-638-19c; p8, 9, *Gspsaurus* models managed by British Journalist Nicholas Allen and prepared by Russian Paleoartist Dr. Dmitry Bogdanov. Scale, each black or white digit is 1 cm.

many footprints and trackways of archosaurs were also discovered from the Mesozoic strata of upper Indus (Kohat-Potwar-Kotli basin), middle Indus (Sulaiman basin) and lower Indus (Kirthar basin) basins of Pakistan [74] [79] [80] [81] [82] [83] [89] [99]. The Kohat-Potwar-Kotli basin yielded the middle-late Jurassic *Malakhelisauroperus mianwali* Ornithopaonia [89] [99], *Samanadrindoperus surghari*

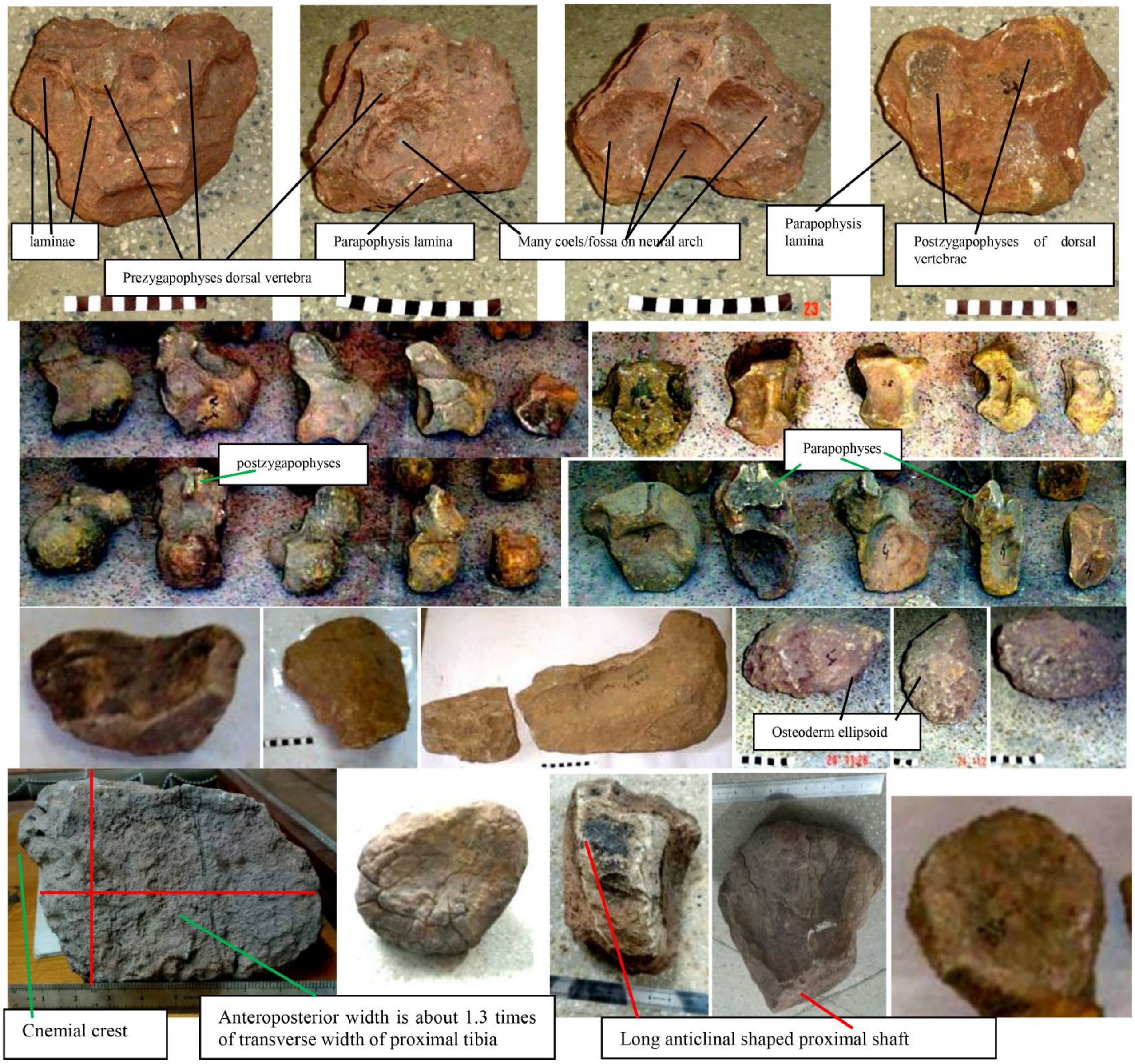

Figure 11. *Gspsaurus pakistani* referred materials from south Kinwa and East Bor. **Row 1**, mid-posterior dorsal vertebral neural arch GSP/MSM-82-4 in four views. **Row 2, 3**, anterior caudal vertebra with partial neural arch GSP/MSM-36-4, and mid-caudal vertebrae with partial neural arch GSP/MSM-37-4, GSP/MSM-38-4, GSP/MSM-39-4, and GSP/MSM-39(a)-4 in 4 views. **Row 4**, mid scapular blade with ventral ridge GSP/MSM-838-4; right mid and proximal scapula GSP/MSM-198-4 (straight; not deflected laterally); proximal and mid femur GSP/MSM-208-4; and osteoderm ellipsoidal plate GSP/MSM-85-4 in 3 views. **Row 5**, proximal tibia GSP/MSM-181-2 in 4 views, and partial proximal tibial shaft GSP/MSM-850-2. Scale, each black or white digit is 1 cm.

and *Himalayadrindoperus potwari* Theropaonia [89] [99]. Sulaiman basin yielded the Maastrichtian *Pashtosauroperus zhobi* Ornithopaonia [89] and *Dgkhansauroperus maarri* Sauropaonia [91], and *Anmolpakhiperus alleni* Pteropaonia [89]. Kirthar basin yielded the Jurassic *Chiltansauroperus nicki* Sauropaonia [89].

3.3.1. Revision of Sauropod Dinosaurs from Pakistan

Here titanosaurian sauropod and theropod are being revised (except *Brohisaurus*

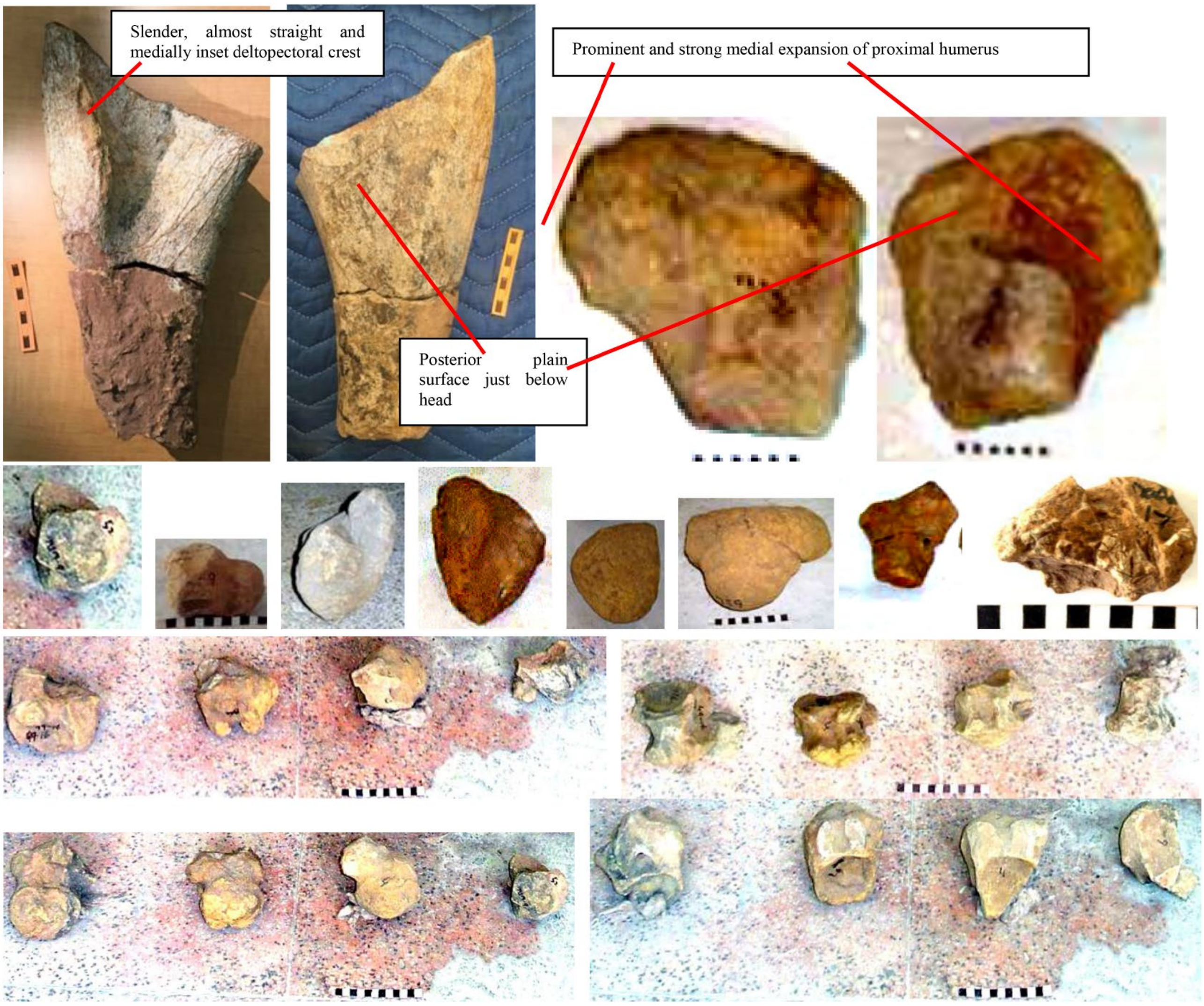

Figure 12. *Ikqaumishan smqureshi* [54] holotypic (row 1, first 2 plates) and referred (rows 1, last 2 plates, rows 2, 3) fossils. **Row 1**, p1, 2, holotypic partial humerus (GSP-UM/Sangiali-1125; in two views) from upper Sangiali; p3, 4, referred partial humerus GSP/MSM-237-10 from Rahi Wali. **Row 2**, p1, caudal vertebra GSP/MSM-52-9 (for scale and different views see in rows 3, 4); p2, caudal vertebra GSP/MSM-793-9, p3, stocky distal tibia GSP/MSM-75-9, p4, right astragalus GSP/MSM-752-9 (transverse length 15cm, anteroposterior width 10 cm), p5, distal ulna GSP/MSM-252-9, p6, proximal humerus with prominent head (mosaic of samples GSP/MSM-694-9 and GSP/MSM-759-9) from Grut; p7, chevron GSP/MSM-321-13 from East Dolwahi for scale see [76]; p8, armor plate GSP/MSM-1095-17 from Dada Pahi. **Row 3**, anterior caudal vertebrae GSP/MSM-49-16 from Top Kinwa (north western corner of Top Kinwa), GSP/MSM-50-4 and GSP/MSM-51-4 from south Kinwa, and GSP/MSM-52-9 from Grut in lateral and ventral views. **Row 4**, anterior caudal vertebrae GSP/MSM-49-16 from Top Kinwa (north western corner of Top Kinwa), GSP/MSM-50-4 and GSP/MSM-51-4 from south Kinwa, and GSP/MSM-52-9 from Grut in anterior and posterior views. Scale, each black or white or yellow digit is 1 cm, for others see [70] [75] [76].

kirthari titanosauriform). The titanosaurs and theropods found from Vitakri Formation (**Figure 1**) in many localities which are shown in Figure 4 of [88] and Figure 1 of [89]. The holotypic localities (Figure 4 of [88]) are being briefly described. Sangiali locality (150 m × 1 km) found on the northern slope of Vitakri dome divided into Lower Sangiali (northwestern Sangiali) yielded *Imrankhanhero zilefatmi*, mid Sangiali yielded *Qaikshaheen masoomniazi* and upper Sangiali

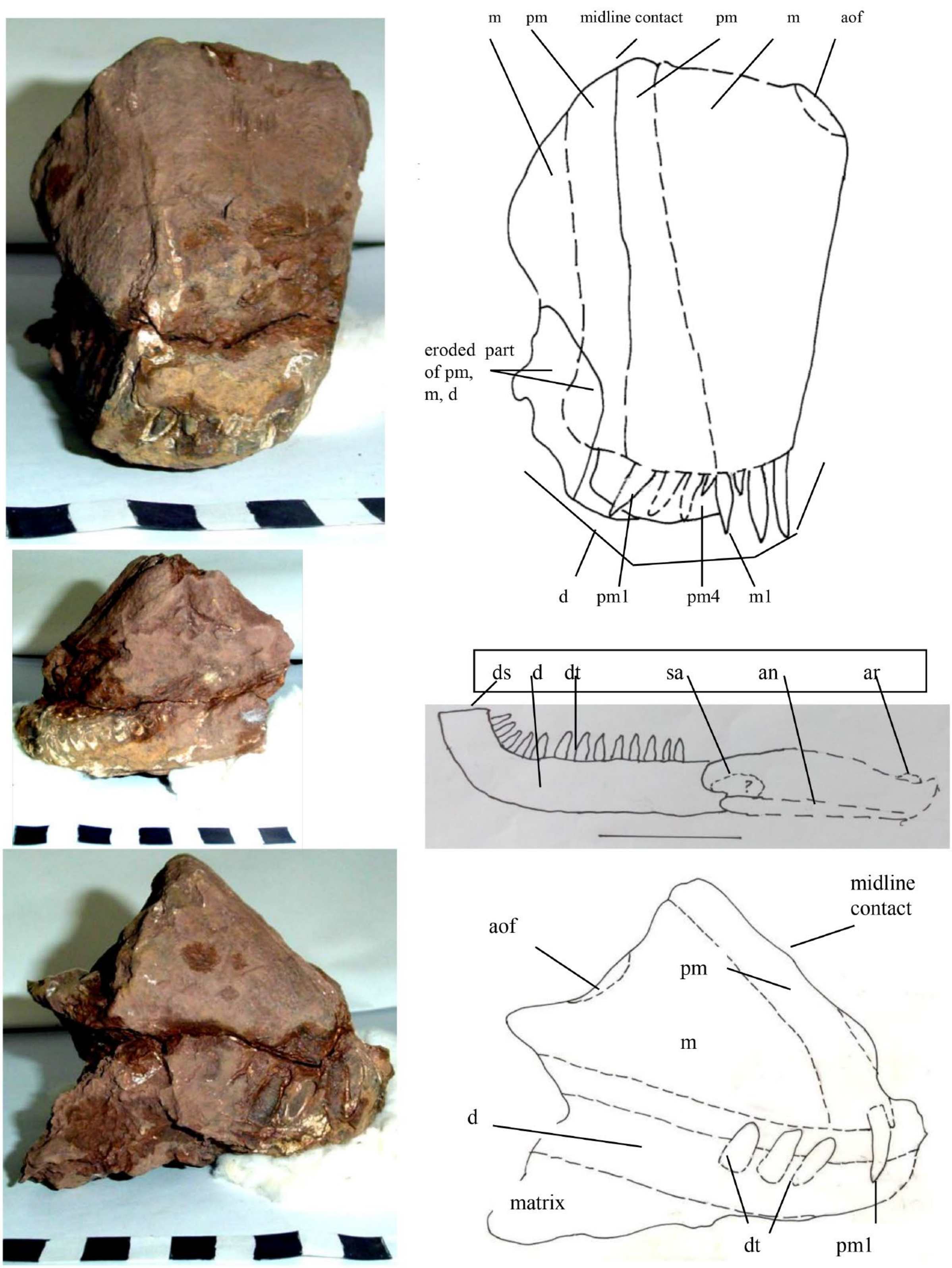

Figure 13. Photographs and line drawings of *Saraikimasoom vitakri* [88] holotype snout articulated with mandible GSP/MSM-142-4 collected from south Kinwa 4 (partially exposed and partially excavated), anterior, left lateral and right lateral views. Scale each black digit is 1 centimeter (cm). Scale bar is 5 cm in line drawing. Abbreviation; a, angular; aof, antorbital fenestra; d, dentary; ds, dentary symphysis; m, maxilla; pm, premaxilla; sa, surangular. Arabic numerals following abbreviations refer to tooth position (e.g., pm 4).

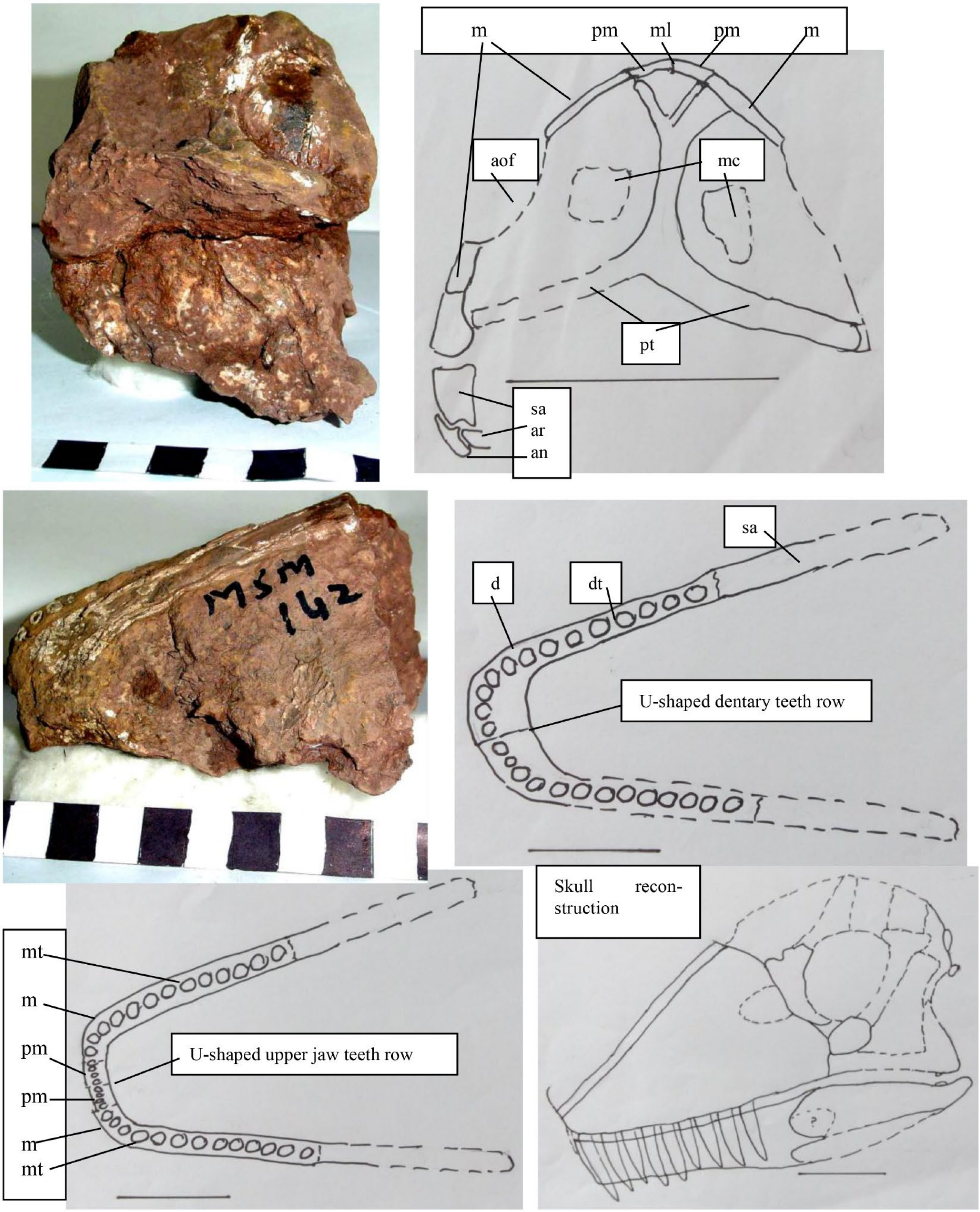

Figure 14. Photograph and line drawings of *Saraikimasoom vitakri* [88] holotype snout articulated with mandible (GSP/MSM-142-4) of collected from south Kinwa 4 (partially exposed and partially excavated), posterior cross sectional view (upper row) and ventral view (middle row). Line drawing of dentary and skull reconstructuion (lower row). Scale each black digit is 1 centimeter (cm). Scale bar is 5 cm in line drawing. Abbreviation; a, angular; aof, antorbital fenestra; d, dentary; m, maxilla; pm, premaxilla; sa, surangular. Arabic numerals following abbreviations refer to tooth position (e.g., pm 4).

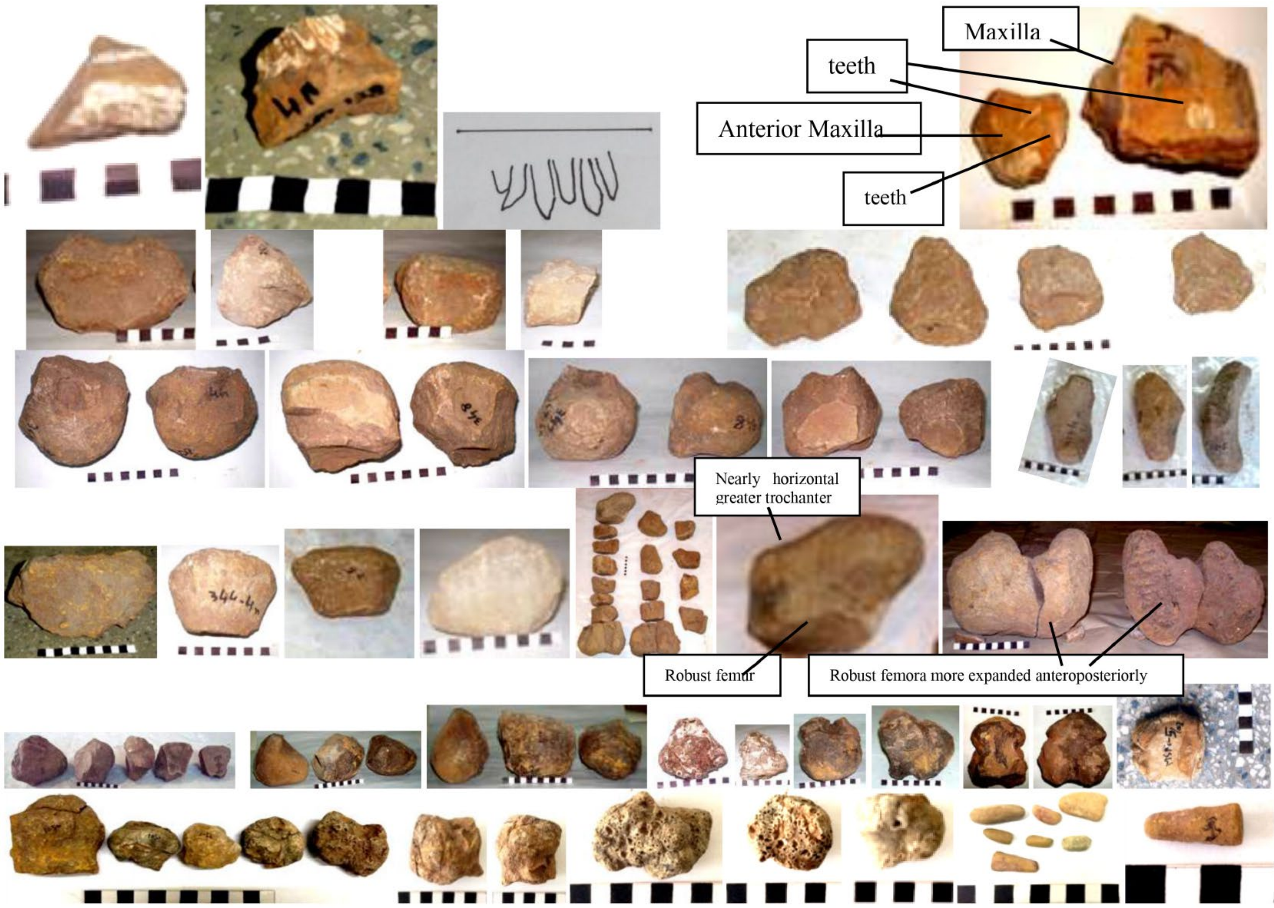

Figure 15. *Nicksaurus razashahi* [89] holotype (rows 1 - 4) and referred fossils (row 5 - 7). **Row 1**, jaw articulated with six teeth GSP/MSM-138-4n (p1, p2) and line drawing (p3); maxilla with 2 or 3 teeth GSP/MSM-315-4n, maxilla/skull bone with 1 tooth GSP/MSM-314-4n. **Row 2**, p1, 2, cervical GSP/MSM-381-4n in 2 views; p3, 4, dorsal vertebra GSP/MSM-382-4n in 2 views; p5, cervicals GSP/MSM-381-4n & GSP/MSM-212-4n, dorsal GSP/MSM-382-4n, cervical GSP/MSM-383-4n. **Row 3**, p1, p2, caudal vertebrae GSP/MSM-347-4n, GSP/MSM-348-4n in 4 views, caudal chevron GSP/MSM-313-4n in 3 views. **Row 4**, p1, proximal scapula with glenoid GSP/MSM-1096-4n; p2 - 4, proximal left radius GSP/MSM-344-4n in 3 views; p5, column 1, left femur GSP/MSM-190-4n; column 2, left and right distal tibiae GSP/MSM-346-4n, GSP/MSM-345-4n); femur sections GSP/MSM-378-4n, GSP/MSM-270-4n; distal femur GSP/MSM-192-4n; column 3, mid scapula parts GSP/MSM-380-4n and GSP/MSM-377-4n, tibia shaft cross section GSP/MSM-379-4n and left humerus GSP/MSM-438-4n; p6, enlarged proximal femur of GSP/MSM-190-4n; p7, left and right distal femur GSP/MSM-190-4n, GSP/MSM-192-4n. **Row 5**, p1, caudal vertebrae GSP/MSM-512-4, GSP/MSM-514-4, GSP/MSM-811-4, GSP/MSM-515-4, GSP/MSM-808-4 from south Kinwa; p2, 3, caudal vertebrae GSP/MSM-1021-4m (north), GSP/MSM-1018-4m (north), GSP/MSM-1019-4m (north) in 2 views, p4, 5, anterior caudal vertebra GSP/MSM-1016-4m in 2 views and p6-9, midcaudal vertebra GSP/MSM-1017-4m-south in 4 views from mid Kinwa; p10, thoracic distal rib GSP/MSM-5/02-Karkh from south Karkh. **Row 6** p1 - 6, five spongy coprolites GSP/MSM-1050 to -54, with enlarged pictures found from Vitakri Dome area, p7, 8, teeth or nodules. Scale each black or white digit is 1 cm. Scale bar is 5 cm.

(south Sangiali) yielded *Ikqaumishan smqureshi*. Bor locality (50 × 500 m) located on western slope of Vitakri dome divided into lower Bor (western Bor) yielded *Khanazeem saraikistani*, mid Bor yielded referred assemblage of *Qaikshaheen masoomniazi* and eastern Bor yielded referred fossils of *Gspsaurus pakistani*. Shalghara locality (100 × 200 m) found on southwestern slope of Vitakri dome yielded referred fossils of *Pakisaurus balochistani*. Kinwa locality (200 × 1 km) found on southern slope of Vitakri dome divided into south Kinwa, southwestern Kinwa, mid Kinwa, north Kinwa and top Kinwa (eastern Kinwa). South Kinwa yielded *Sulaimanisaurus gingerichi* and *Saraikimasoom vitakri* and referred assemblage of *Gspsaurus pakistani*, southwestern Kinwa yielded *Pakisaurus balochistani*, mid Kinwa yielded *Khetranisaurus barkhani* and referred fossils of

Figure 16. *Balochisaurus malkani* [89] holotypic vertebral bones found from southern Mari Bohri. **Rows 1, 2**, three cervical vertebrae GSP/MSM-126-15, GSP/MSM-127-15, GSP/MSM-128-15, and two dorsal vertebrae GSP/MSM-129-15, GSP/MSM-130-15 in laterodorsal, anterodorsal, posterodorsal and anteroventral views. **Row 3**, four dorsal vertebrae GSP/MSM-824-15, GSP/MSM-823-15, GSP/MSM-828-15, GSP/MSM-818-15; unknown/distal rib GSP/MSM-672-15; cervical rib GSP/MSM-881-15 in 2 views, proximal rib of dorsal vertebra GSP/MSM-322-15 in 2 views; mid rib GSP/MSM-531-15 of dorsal vertebra; dorsal neural spine with post zygapophyses and prespinal laminae of dorsal vertebra GSP/MSM-323-15 in three views. **Rows 4, 5, 6, 7,** anterior and mid caudal vertebrae GSP/MSM-43-15 (biconvex first caudal), GSP/MSM-44-15, GSP/MSM-44a-15, GSP/MSM-45-15, GSP/MSM-46-15, GSP/MSM-47-15, GSP/MSM-48-15 in lateral, posterodorsal, posteroventral and anterodorsal views. **Row 8**, two caudal vertebrae GSP/MSM-260-15, GSP/MSM-505-15; distal caudal vertebra GSP/MSM-834-15 with prominent articular ring; neural arch of dorsal vertebra GSP/MSM-324-15; distal caudal neural arch GSP/MSM-325-15 in 3 views, chevron part GSP/MSM-1056-15. Scale, each black/white digit is 1 cm.

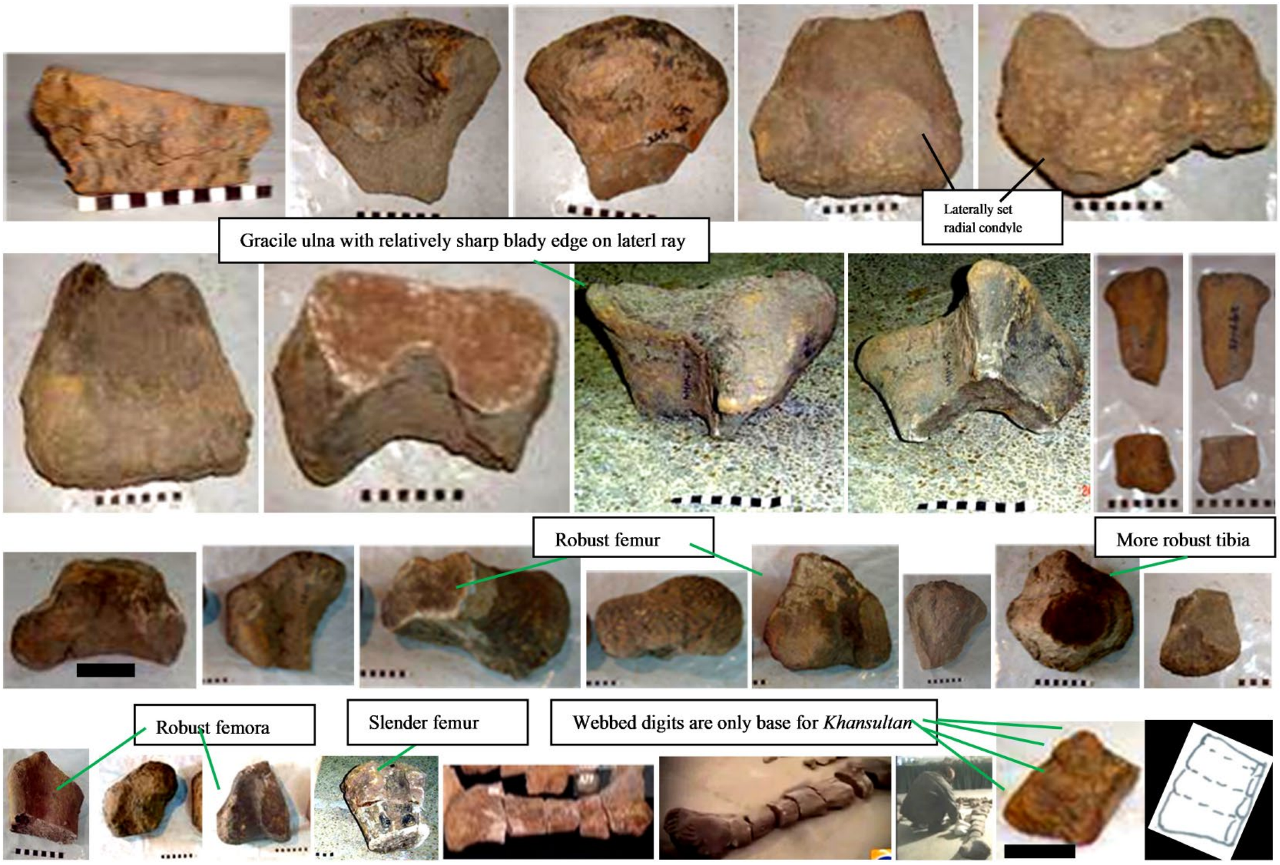

Figure 17. *Balochisaurus malkani* [89] holotypic appendicular bone assemblage (rows 1 - 3) and its referred fossils (p1, 2, 3, of row 4. For p4-9 of row 4, see below) found from southern Mari Bohri locality. **Row 1**, left anterior sternal GSP/MSM-675-15; left proximal humerus GSP/MSM-245-15 in anterior and posterior views; and distal humerus GSP/MSM-174-15 in anterior and ventral views. **Row 2**, distal left humerus GSP/MSM-174-15 in posterior and cross sectional views; left proximal ulna GSP/MSM-78-15 in posterior and ventral views; proximal metacarpal GSP/MSM-297-15 (upper) and distal metacarpal GSP/MSM-750-15 (lower) in 2 views. **Row 3**, left acetabulum GSP/MSM-166-15 in ventral view; left proximal femur GSP/MSN-168-15 in posterior, ventral and dorsal views; and distal left femur GSP/MSM-173-15 in posterior view; proximal left tibia in lateral and ventral views GSP/MSM-246-15; distal ulna GSP/MSM-227-15. **Row 4, p1 - 3**, proximal right femora GSP/MSM-749-15 and GSP/MSM-167-15, and distal left femur GSP/MSM-170-15; **p4**, distal right slender femur GSP/MSM-71-15 (referable to Gspsaurus) and **p5, 6, 7,** miscellaneous fossils. **P8, 9**, plantar webbed pes foot GSP/MSM-675-15 of *Khansultan masoomrashidi* new genus and new species found from southern Mari Bohri of Barkhan District, Balochistan. Scale, each black/white digit is 1cm. Black scale bar is 5 cm.

Ikqaumishan smqureshi and *Nicksaurus razashahi*, north Kinwa yielded *Nicksaurus razashahi* and top Kinwa yielded *Imrankhanshaheen masoombushrai* and referred fossils of *Khanazeem saraikistani*. Alam locality (100 × 600 m) found on southeastern slope of Vitakri dome divided into south Alam, central or mid Alam, and north Alam. Central/mid Alam yielded *Gspsaurus pakistani* and *Maojandino alami*, north Alam yielded referred fossils of *Pakisaurus balochistani*. Mari Bohri (Kachi Bohri) locality found on eastern plunge of southern Fazil Chel-Mari Bohri anticline. Mari Bohri is divided into north Mari Bohri which yielded *Marisaurus jeffi* and south Mari Bohri yielded *Balochisaurus malkani*. Besides Sangiali, Bor, Shalghara, Kinwa and Alam localities, the following localities host observed bones. Dada Pahi locality PDL-17 (N 29˚40'50" and E 69˚24'38") found on eastern slope of Vitakri Dome and has observed bone assemblage. East

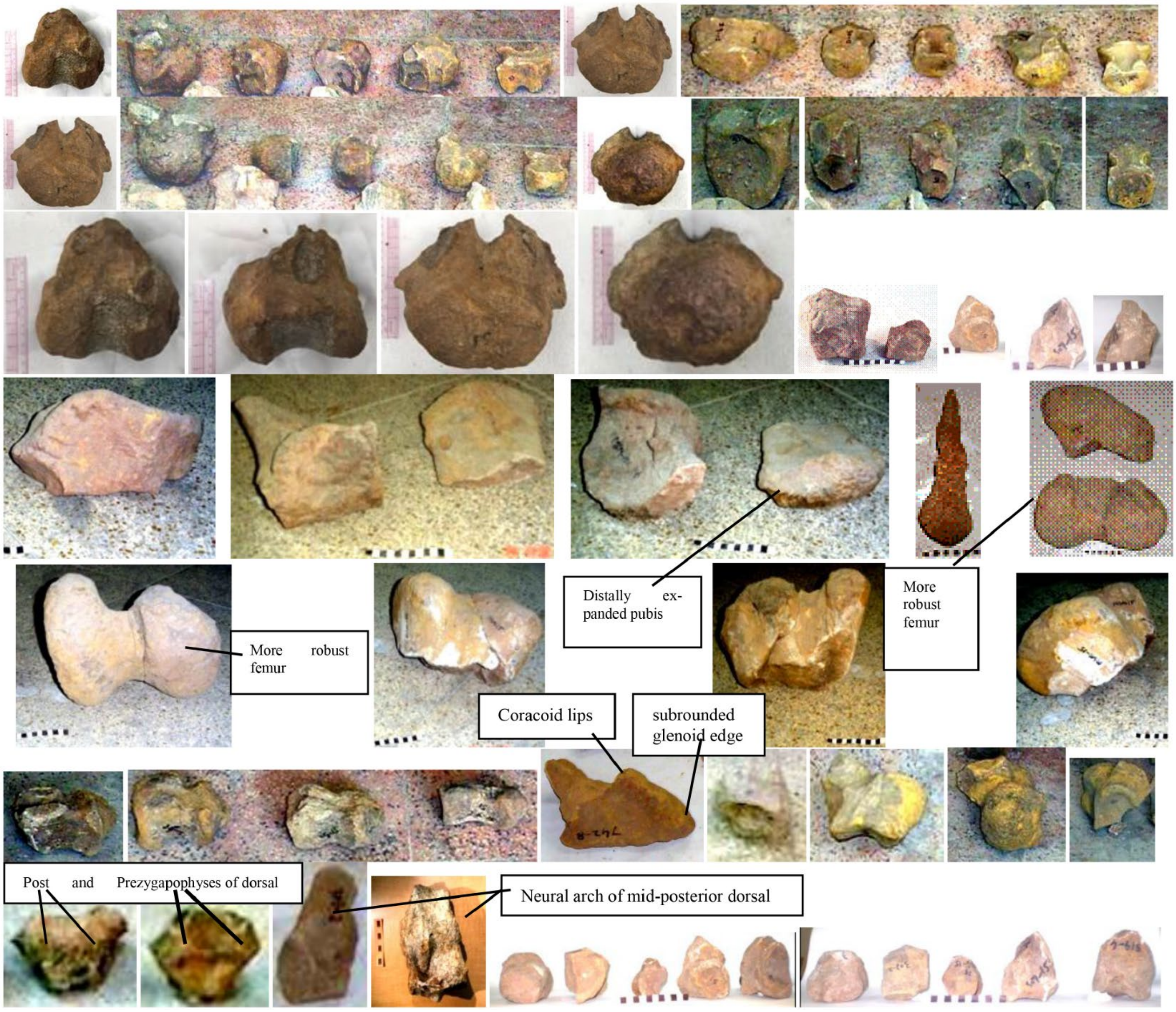

Figure 18. *Marisaurus jeffi* [89] holotypic bones (rows 1 - 5) from northern Mari Bohri and its referred (row 6). **Rows 1, 2**, biconvex first anterior caudal vertebra GSP/MSM-7-15, anterior caudal vertebra GSP/MSM-29-15 and mid-caudal vertebrae GSP/MSM-30-15, GSP/MSM-31-15, GSP/MSM-32-15, GSP/MSM-33-15 in 4 views. **Row 3**, biconvex first anterior caudal vertebra GSP/MSM-7-15 in 4 views; caudal vertebrae GSP/MSM-815-15 and GSP/MSM-506-15; distal caudal neural arch GSP/MSM-507-15 in ventral, anterior and lateral views showing prezygapophyses and postzygapophysis with neural spine. **Row 4**, right proximal scapula GSP/MSM-163-15; proximal pubis GSP/MSM-165-15 and distal pubis GSP/MSM-164-15 in 2 views; distal pubis GSP/MSM-164-15; proximal femur GSP/MSM-169-15 (upper) and distal femur GSP/MSM-70-15 (lower). **Row 5**, distal femur GSP/MSM-70-15 in 4 views. **Row 6**, Referred caudal vertebrae GSP/MSM-15-15 (p1), GSP/MSM-24-15, GSP/MSM-25-15 and GSP/MSM-26-15 (p2) may be found from Mari Bohri type locality; and coracoid GSP/MSM-742-8 (p3), dorsal vertebra GSP/MSM-134-8 (p4), and caudal vertebra GSP/MSM-40-8 (p5-7) from Darwaza locality in 3 views of *Marisaurus jeffi*. **Row 7**, partial neural arch (p1, 2) of anterior-mid dorsal GSP/MSM-123-2, dorsal neural arches with postzygapophyses GSP/MSM-792-2 (about 12cm preserved length) (p3) found from mid Bor, and GSP-UM/Sangiali-1104 (p4) found from mid Sangiali of *Qaikshaheen masoomniazi* [54]; p5,6, comparison of neural arch of distal caudals in ventral and dorsal views GSP/MSM-521-3 of *Pakisaurus balochistani*, GSP/MSM-302-2 of *Qaikshaheen masoomniazi*, GSP/MSM-325-15 of *Balochisaurus malkani*, GSP/MSM-507-15 of *Marisaurus jeffi* and GSP/MSM-519-4 of *Pakisaurus balochistani*; Scale each black or white digit is 1 cm, for other scale see [70] [71] [74] [76]. For biconvex vertebra the scale is in cm and inches, total scale 15 cm.

Alam PDL-18 locality is located on southeastern slope of Vitakri dome. These are four major zones of east Alam 18. First zone is L-shaped (N 29˚41'22"

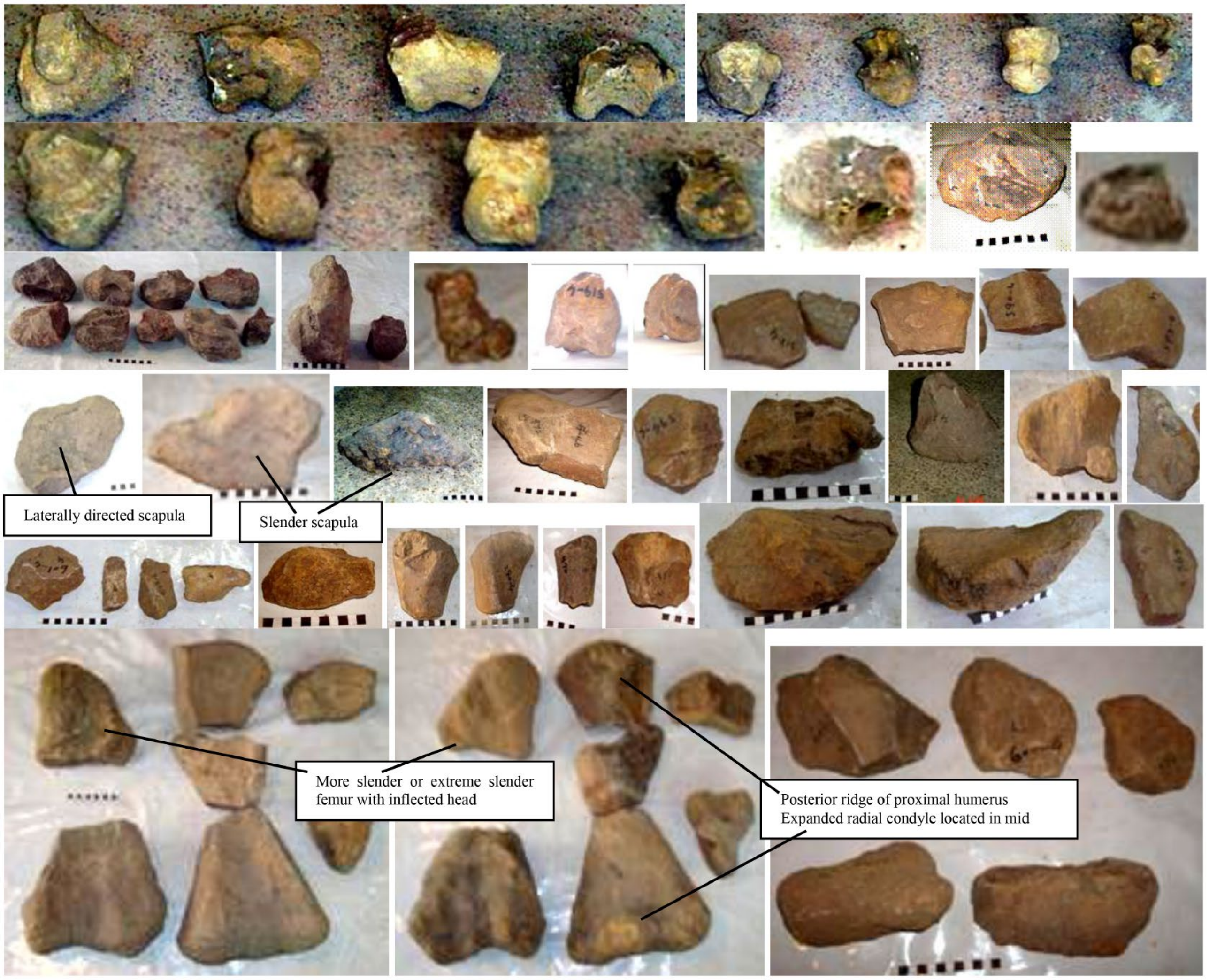

Figure 19. *Pakisaurus balochistani* [88] holotype from south Kinwa. **Row 1**, anterior caudal vertebra GSP/MSM-11-4, and mid-caudal vertebrae GSP/MSM-12-4, GSP/MSM-13-4 and GSP/MSM-14-4 in lateral and ventral views. **Row 2**, anterior caudal vertebra GSP/MSM-11-4, and mid caudal vertebrae GSP/MSM-12-4, GSP/MSM-13-4 and GSP/MSM-14-4 in posterior view; cervicodorsal vertebra GSP/MSM-133-4; dorsal vertebra GSP/MSM-1011-4; sacral pair GSP/MSM-1008-4. **Row 3**, p1, subrow 1, presacral vertebrae GSP/MSM-340-4, GSP/MSM-809-4, GSP/MSM-1011-4, GSP/MSM-517-4; subrow 2, presacral vertebrae GSP/MSM-810-4, GSP/MSM-342-4, GSP/MSM-800-4, GSP/MSM-341-4, GSP/MSM-376-4; p2, anterior and mid caudal vertebrae GSP/MSM-207-4 and GSP/MSM-763-4; p3, mid caudal vertebra GSP/MSM-1010-4; p4, 5, distal caudal neural arch GSP/MSM-519-4; p6, proximal scapula in 2 pieces GSP/MSM-318-4, GSP/MSM-319-4; p7, proximal scapula GSP/MSM-201-4; p8, mid scapula GSP/MSM-590-4; p9, mid scapula sections GSP/MSM-593-4. **Row 4**, left mid scapula GSP/MSM-203-4, right distal scapula with glenoid surface GSP/MSM-205-4; left distal scapula with glenoid surface GSP/MSM-162-4; proximal anterior process of ilium GSP/MSM-971-4 and GSP/MSM-972-4; neural arch GSP/MSM-594-4; posterior part of ilium with part of attached sacral ribs GSP/MSM-806-4; distal radius GSP/MSM-159-4; proximal fibula GSP/MSM-349-4; distal fibula GSP/MSM-580-4. **Row 5**, p1, cervical neural spine GSP/MSM-601-4, partial neural arches of dorsal and caudals GSP/MSM-805-4, -878-4, -804-4; p2, partial neural arch GSP/MSM-878a-4; p3, 4, partial metacarpal GSP/MSM-280-4 in 2 views; p5, 6, partial metacarpals GSP/MSM-970-4, GSP/MSM-350-4; p7, 8, anterolateral sternal GSP/MSM-355-4 in 2 views; p9, sternal medial convex GSP/MSM-598-4. **Row 6**, p1, 2, column 1, proximal left femur GSP/MSM-595-4 and distal left femur GSP/MSM-200-4; column 2, proximal humerus GSP/MSM-202-4, mid humerus GSP/MSM-268-4, distal humerus GSP/MSM-193-4 (reverse view than proximal); column 3, mid humerus cross sections GSP/MSM-210-4, GSP/MSM-210a-4. p3, subrow 1, left and right proximal ulnae GSP/MSM-603-4 and GSP/MSM-600-4, proximal left fibula GSP/MSM-384-4; subrow 2, rays of proximal ulna GSP/MSM-211-4 and GSP/MSM-678-4. Scale, each black or white digit is 1 cm, for others scale see [70] [76] [86].

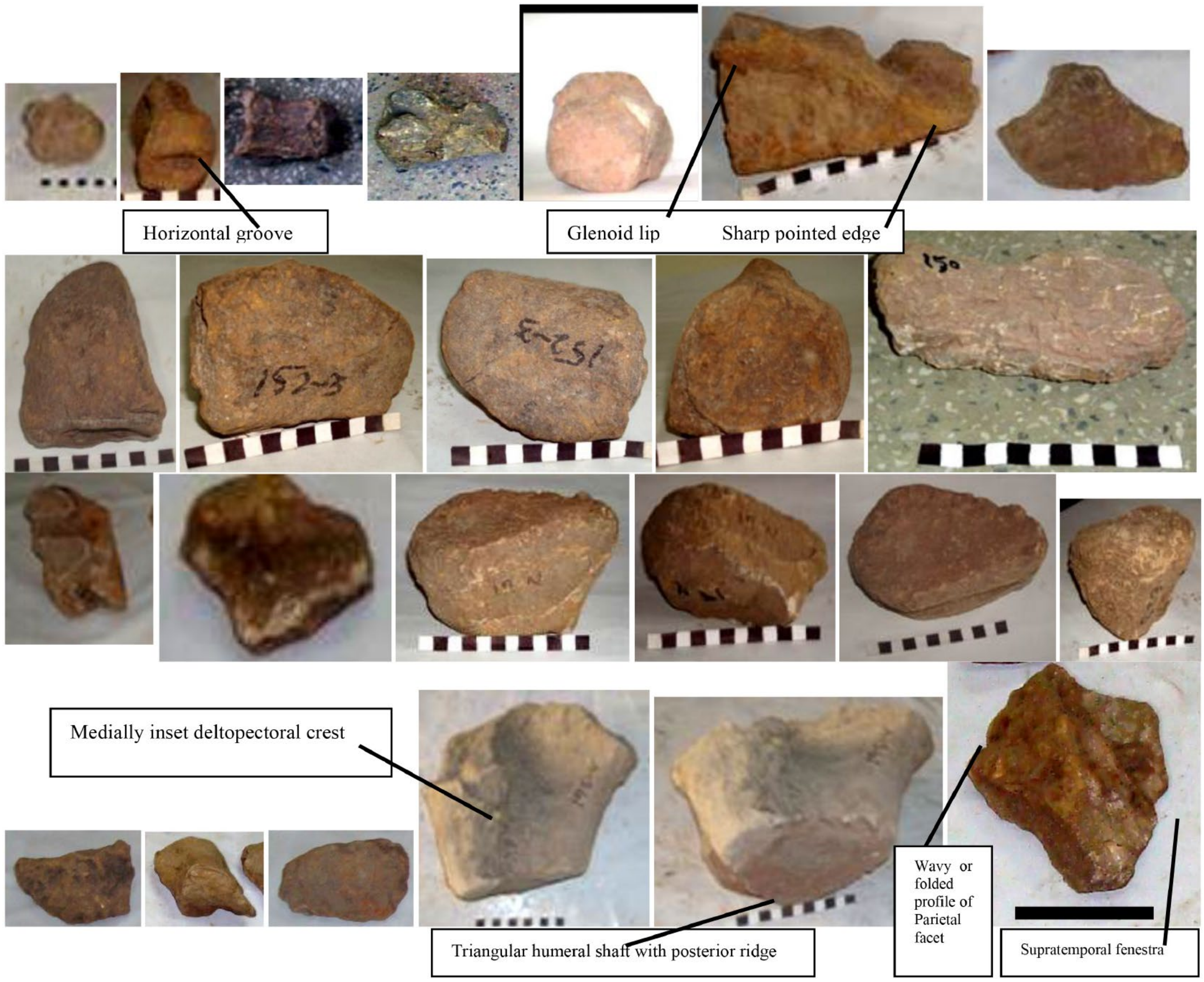

Figure 20. *Pakisaurus balochistani* referred materials (rows 1 - 2 from Shalghara and Row 3 from north Alam and row 4 from south Kinwa). **Row 1**, fractured distal caudal vertebra GSP/MSM-523-3; distal caudal vertebra with horizontal groove on posterior cone GSP/MSM-151-3 in posterior and lateral views; caudal vertebra GSP/MSM-23-3, distal caudal neural arch GSP/MSM-521-3; coracoid GSP/MSM-366-3; ulna GSP/MSM-748-3. **Row 2**, ungual GSP/MSM-152-3 in four views, thick armour spine/plate GSP/MSM-150-3. **Row 3**, dorsal vertebra GSP/MSM-758-19n, partial acetabulum GSP/MSM-403-19n; proximal radius GSP/MSM-756-19n in 3 views and distal ulna GSP/MSM-628-19n from north Alam. **Row 4**, proximal scapula GSP/MSM-335-4; mid scapula GSP/MSM-267-4, scapular part GSP/MSM-678-4, proximal right humerus GSP/MSM-195-4 in anterior and anteroventral views, and right parietal GSP/MSM-353-4 (a few teeth on its surface) found from South Kinwa. Scale each black or white digit is 1 cm, for others scale see [70] [76]. Black scale bar is 5 cm.

and E 69˚24'11") located northwestern part of East Alam area has oberved bone assemblage. Second zone is straight exposures (N 29˚41'22" and E 69˚24'21") hosts observed bone assemblage of *Ikqaumishan smqureshi*. This second zone is east of zone first. Third zone is eastern zone of east Alam (N 29˚41'08" and E 69˚24'25") host observed bones. This zone has southward bend from second zone. The fourth zone is around the central ridge (N 29˚41'09" and E 69˚24'11") host observed bone assemblage. Rosmani locality PDL 20 has observed bones (N 29˚41'34" and E 69˚24'16"). Bones found in the grid site and also in surroundings. Many intact bones were also found (pages 1097-1098 of [54]). The bones of

Figure 21. *Khanazeem saraikistani* [90] holotype (rows 1 - 3) from lower Bor, and referred bones from western Top Kinwa (row 4, except last photo of holotypic proximal humerus). **Row 1**, p1, 2, dentary ramus with articulated teeth GSP/MSM-143-2; p3, column 1, proximal right tibia GSP/MSM-72-2, distal right tibia GSP/MSM-186-2; column 2, femur GSP/MSM-293-2 (may be adjusted with proximal and mid femur GSP/MSM-294-2), proximal right humerus GSP/MSM-180-2; column 3, proximal and mid right femur GSP/MSM-294-2, distal right femur GSP/MSM-266-2; column 4, mid right humerus GSP/MSM-289-2, humerus part GSP/MSM-498-2; column 5, proximal and mid left humerus GSP/MSM-288-2, mid humerus GSP/MSM-290-2, mid left tibia GSP/MSM-286-2; p4, proximal left femur GSP/MSM-69-2 (upper) and distal condyles GSP/MSM-272-2 and GSP/MSM-265-2 (lower). **Row 2**, p1 - 3, distal fibula GSP/MSM-183-2; p4-6, part of distal femur GSP/MSM-233-2; p7 - 10, caudal vertebra GSP/MSM-16-2 for scale see [70], and p11, caudal vertebra GSP/MSM-793-2. **Row 3**, p1, 2, proximal left femur GSP/MSM-69-2 and proximal right femur GSP/MSM-294-2; p3, proximal right femur GSP/MSM-294-2, mid femur GSP/MSM-293-2 and distal GSP/MSM-266-2 parts; p4, proximal right humerus GSP/MSM-180-2 in two views, mid right humerus GSP/MSM-289-2 and; p5, proximal left humerus GSP/MSM-288-2, mid humerus GSP/MSM-290-2; p6, proximal right tibia GSP/MSM-72-2 and distal tibia GSP/MSM-186-2; p7, proximal and mid left tibia GSP/MSM-286-2. **Row 4**, p1 - 3, caudal vertebrae GSP/MSM-17-16 (for scale see [70]), GSP/MSM-510-16 and GSP/MSM-154-16; p4, chevron GSP/MSM-330-16 and prezygapophyses GSP/MSM-327-16; p5, 6, chevron GSP/MSM-330-16; p7, ulna GSP/MSM-1032-16, p8, holotypic proximal right humerus GSP/MSM-180-2. Scale, each black digit is 1 cm.

titanosaurs sauropod collected from Vitakri Formation represent about 60% vertebral elements, about 5% cranial elements and appendicular elements about

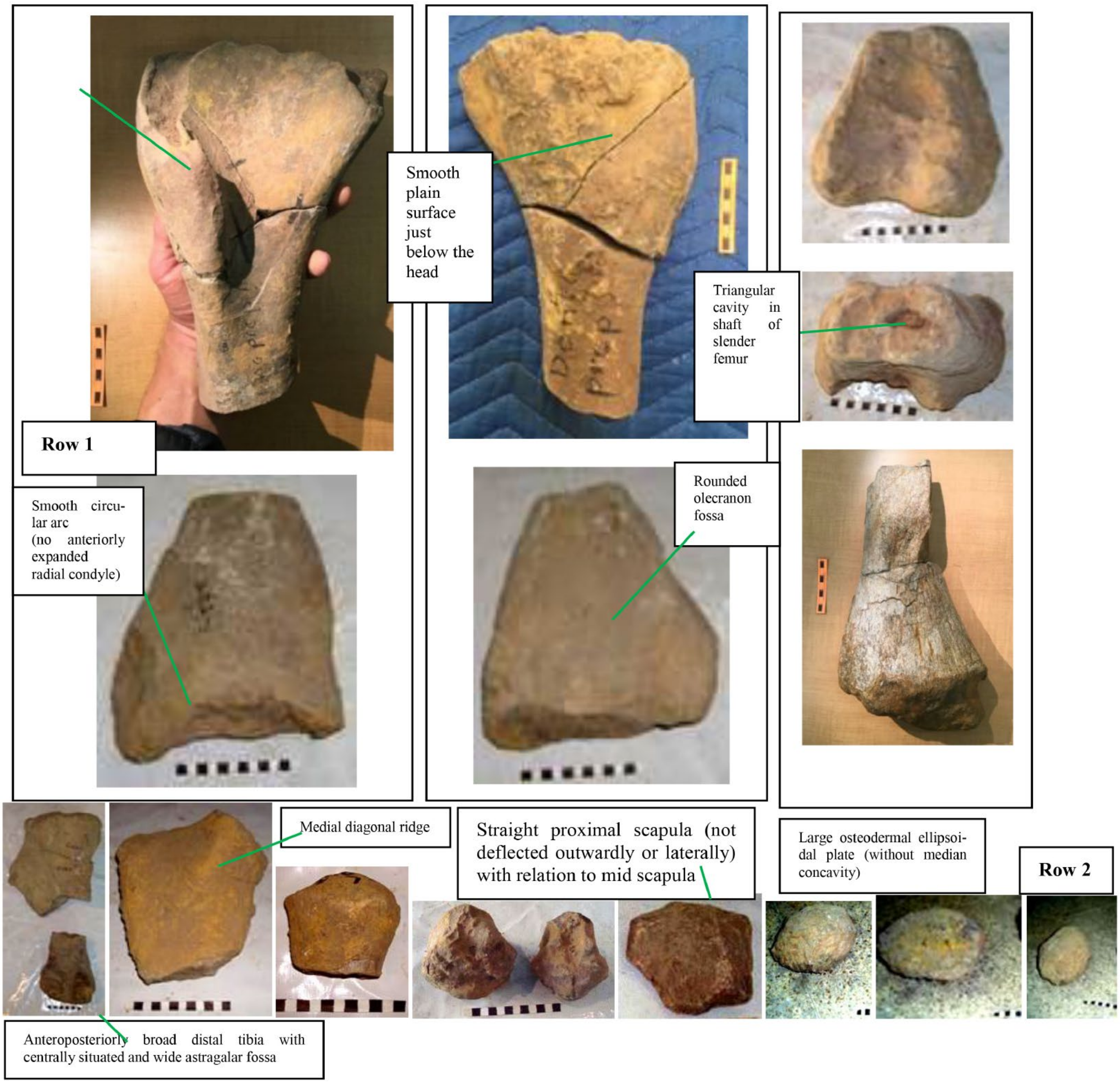

Figure 22. *Imrankhanhero zilefatmi* [54] holotypic specimen (Row 1, plates/column 1, 2, 3) found from lower Sangiali locality and referred specimen (Row 2, p1 - 8) found from Zubra peak locality. **Row 1**, **columns 1, 2,** A partial humerus (GSP-UM/Sangiali-1124; GSP/MSM-262-1) in anterior (column 1) and posterior (column 2) views; **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**, p1, flattened and transversely compressed right tibia GSP/MSM-235-7 with anteroposteriorly broad distal tibia; p2, proximal right fibula GSP/MSM-253-7; p3, right metatarsal GSP/MSM-296-7; p4, anterior caudal vertebrae GSP/MSM-523-7, GSP/MSM-524-7 in ventral view; p5, right mid scapula GSP/MSM-746-7 in lateral view, p6 - 8, osteoderm ellipsoid GSP/MSM-84-7 in 3 views from south Zubra. Scale each black or white/yellow digit is 1 cm.

35% [92]. Although cranial 5% is in low fraction but have significant and diverse snouts and other cranial materials. Among vertebral elements the cervical, dorsal and sacral vertebrae are about 30% and caudal vertebra are about 30%. Anterior, mid and distal caudal vertebrae have balanced fraction. Among vertebrae the some are only centra and some have articulated partial neural arches and a few are almost complete vertebrae. Besides these, numerous partial neural arches

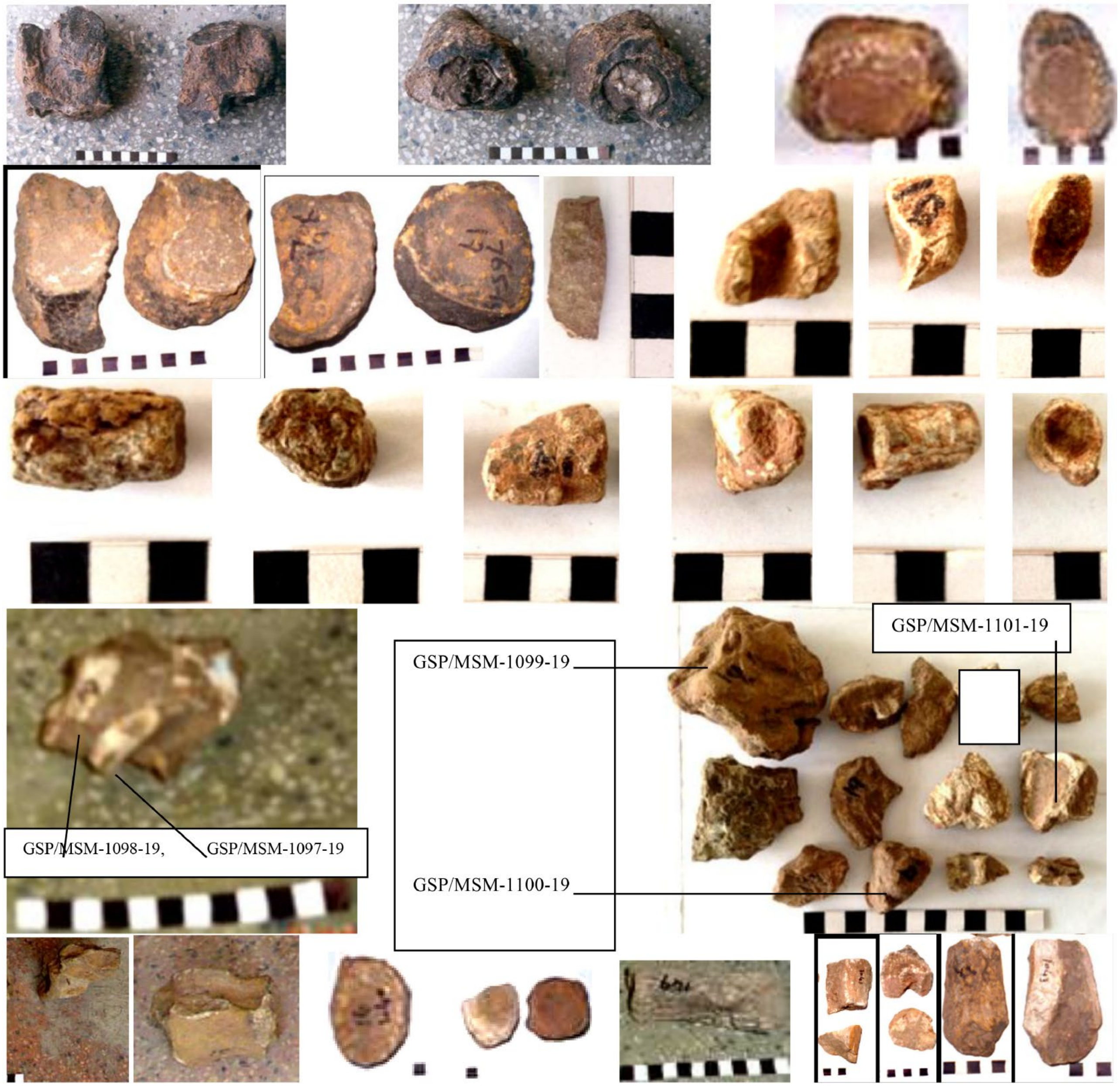

Figure 23. *Vitakridrinda sulaimani* [88] holotypic bones (Rows 1 - 4) found from Alam, and referred fossils (row 5). **Row 1**, left and right femora GSP/MSM-59-19 and GSP/MSM-60-19 in 2 views; distal femur cross section GSP/MSM-1039-19 in 2 views. **Row 2**, tall dorsal centra GSP/MSM-706-19 and GSP/MSM-765-19 in 2 views; tooth GSP/MSM-1085-19; tooth cross section GSP/MSM-1093-19; tooth cross section GSP/MSM-1090-19 in 2 views. **Row 3**, teeth GSP/MSM-1089-19, GSP/MSM-1091-19 and GSP/MSM-1092-19 in 2 views. **Row 4**, p1, two teeth GSP/MSM-1097-19 and GSP/MSM-1098-19 as labeled; p2, only three labeled teeth GSP/MSM-1099-19, GSP/MSM-1100-19 and GSP/MSM-1101-19 (along with many cranial fragments). **Row 5**, anterior dorsal vertebra GSP/MSM-56-1 from Sangiali, anterior caudal vertebra GSP/MSM-58-15 from Mari Bohri; tall dorsal vertebra GSP/MSM-1040-16 and GSP/MSM-1048-16 from Top Kinwa; squarish mid caudal centrum GSP/MSM-282-15 from Mari Bohri; distal caudal vertebra GSP/MSM-149-16 of whiplash tail, and metatarsals II/teeth (GSP/MSM-1041-16 upper; GSP/MSM-1042-16 lower) in 2 views from Top Kinwa; metatarsal III or tooth (GSP/MSM-1043-4) in 2 views from south Kinwa. Scale, every black or white digit is 1 cm.

were also collected. Among appendicular elements, the femora, tibiae, humeri, ulnae and scapulae were common, while pelvic girdles were less in fraction.

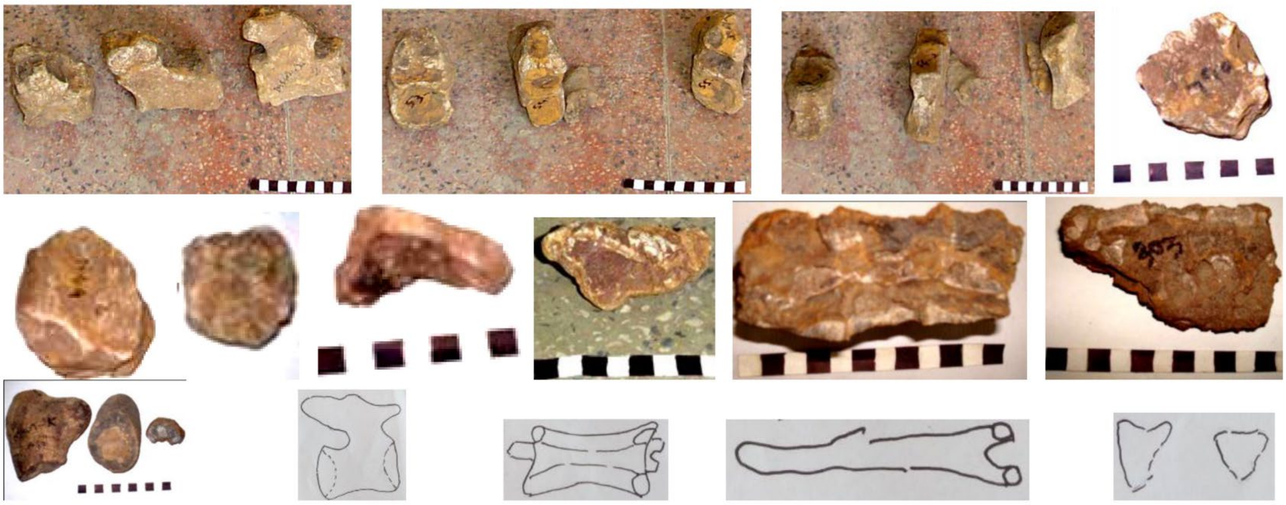

Figure 24. *Vitakrisaurus saraiki* [88] holotype (row 1 and 2) collected from mid Bor locality, Barkhan district, Balochistan, and referred fossils (row 3). **Row 1**, one anterior caudal GSP/MSM-53-2 and two mid-caudal vertebrae GSP/MSM-54-2 and GSP/MSM-55-2 in 3 view; partial vertebra GSP/MSM-780-2. **Row 2**, humerus cross sectional bones GSP/MSM-1044-2, GSP/MSM-984-2 and GSP/MSM-1027-2, proximal ulna GSP/MSM-1076-2 cross sectional view, right hand/manus GSP/MSM-303-2 in dorsal and medial views. **Row 3**, p1, proximal femur GSP/MSM-1049-K, mid cross section of femur GSP/MSM-1055-K, and peripheral bone of leg section GSP/MSM-1059-K from Karkh locality of Khuzdar District, Balochistan, P2, 3, Line drawings of tall amphicoelous caudal vertebra K 20/316 in right lateral and ventral views from Bara Simla, India; p4, its neural arch including prezygapophysis and postzygapophysis in dorsal view, and p5, two small chevrons K 20/318 from Bara Simla, India. Scale, every black or white digit is 1 cm.

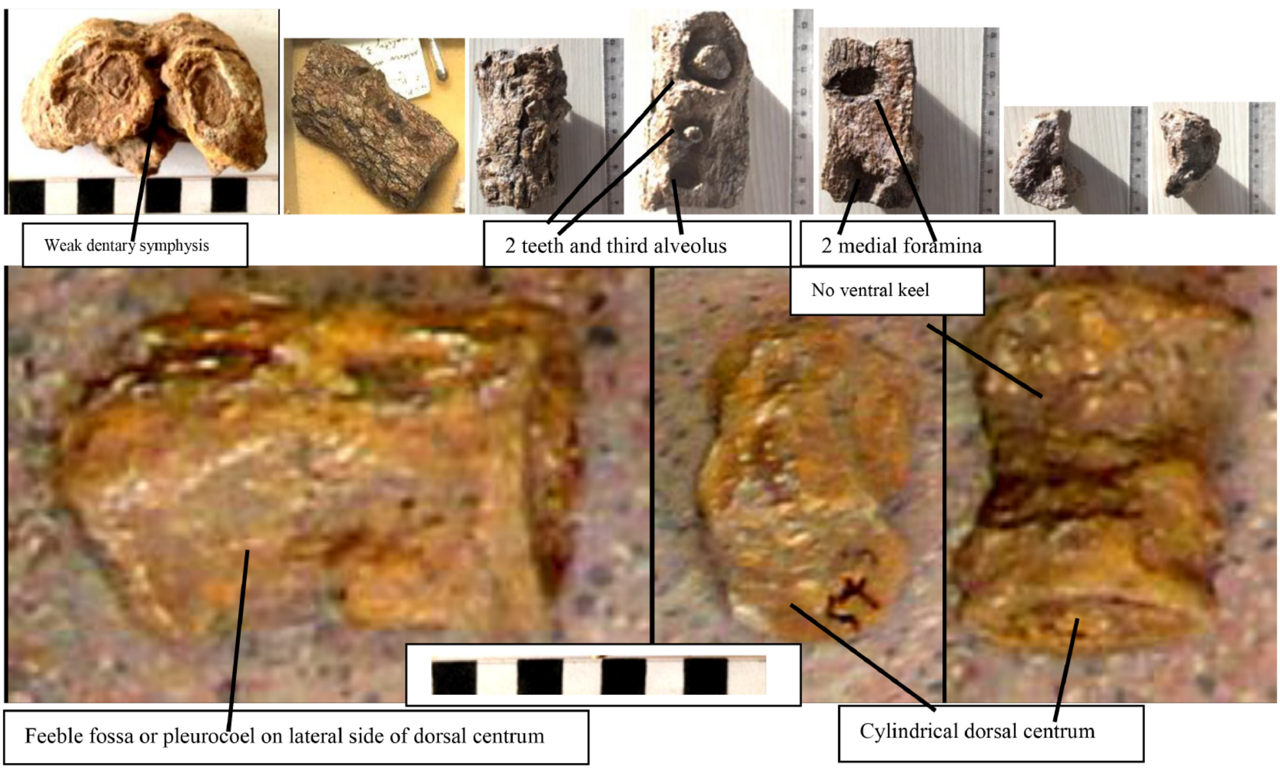

Figure 25. *Shansaraiki insafi* [90] holotype . **Row 1**, Anterior dentary with weak symphysis GSP/MSM-140-3, and dentary ramus with two teeth and third alveolus GSP-UM/MSM-5-3 in 6 views. **Row 2**, dorsal vertebra GSP/MSM-57-3 in 3 views. Scale, each black and white digit is 1 cm. Scale in photos 3 - 7 of row 1 is in centimeter.

Gspsauridae [81] vide [88]

Represented by Gspsaurinae [81] vide [88], which includes *Gspsaurus pakistani*, *Maojandino alami*, *Ikqaumishan smqureshi*, and new genus and new species *Imrankhanshaheen masoombushrai*).

1) *Gspsaurus pakistani* [79] vide [88]

Its holotypic and referred specimens (**Figures 8-11**), type and referred localities, horizon and age, year of informal and formal description, number of individual and basinal distribution were mentioned in (**Table 8**). Its fossils are described and figured in [84]. Its diagnostic features, comparison and brief descriptions are presented as below.

Table 8. Statistical data and basic information of Gspsauridae Poripuchian titanosaurs (Sauropoda, Dinosauria) found from the latest Maastrichtian) 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*. 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 most of specimens the last number represents locality number except the most of the Sangiali specimens. 25 Pakistan Dinosaur Localities (PDL-1 to PDL-25) (pages 66-70 of [75]; Figure 4 of [88]; Figure 1 of [89]) were reported. These last four sentences also apply in (**Tables 9-11**).

Titles	*Gspsaurus pakistani*	*Maojandino alami*	*Ikqaumishan smqureshi*	*Imrankhanshaheen masoombushrai*
Informal Description	[79]	[80]	-	-
Formal Description	[88]	[89]	[54]	In present research
Holotype	Snout articulated with dentary rami, quadrate, and quadratojugal GSP/MSM-79-19; a partial vomer, palatine, and pterygoid GSP/MSM-80-19; braincase/anterior caudal GSP/MSM-62-19; cervical vertebrae GSP/MSM-107-19, GSP/MSM-108-19, GSP/MSM-109-19, GSP/MSM-437-19, GSP/MSM-220-19, GSP/MSM-502-19; dorsal vertebrae GSP/MSM-110-19, GSP/MSM-111-19, GSP/MSM-112-19, GSP/MSM-617-19; anterior caudal vertebrae GSP/MSM-218-19, GSP/MSM-219-19; caudal vertebrae GSP/MSM-113-19, GSP/MSM-114-19, GSP/MSM-115-19, GSP/MSM-116-19, GSP/MSM-117-19, GSP/MSM-221-19, GSP/MSM-696-19, GSP/MSM-777-19; neural arch GSP/MSM-146-19; left and right partial proximal scapula GSP/MSM-1100-19, GSP/MSM-217-19; proximal radius GSP/MSM-215-19; partial ilium GSP/MSM-216-19; proximal left femur GSP/MSM-213-19; distal left femur GSP/MSM-118-19; proximal left tibia GSP/MSM-119-19; distal left tibia GSP/MSM-569-19; distal right tibia GSP/MSM-710-19. (**Figures 8-10**).	*Same as *Gspsaurus pakistani* except the cranial specimen (GSP/MSM-79-19 and GSP/MSM-80-19). (**Figure 10** & **Figure 11**).	A partial proximal and mid humerus GSP-UM/Sangiali-1125. (Figure 13 of [54]). (**Figure 12**).	Braincase (GSP/MSM-2-16 and GSP-UM 7000); cervical vertebra GSP/MSM-131-16; dorsal vertebra GSP/MSM-132-16; anterior dorsal vertebra GSP/MSM-256-16; dorsal vertebrae with ventral ridge GSP/MSM-774-16 and GSP/MSM-511-16; two coosified sacral vertebrae GSP/MSM-137-16; two coosified sacral vertebrae GSP/MSM-776-16; anterior caudal vertebra GSP/MSM-34-16; mid-caudal vertebra GSP/MSM-35-16; distal caudal vertebra GSP/MSM-153-16; left and right proximal scapulae GSP/MSM-250-16 and GSP/MSM-176-16; mid humerus GSP/MSM-468-16; left and right proximal ulna GSP/MSM-175-16 and GSP/MSM-240-16; distal ulna GSP/MSM-74-16; distal radius GSP/MSM-160-16; metacarpal GSP/MSM-1036-16; acetabulum in 2 pieces GSP/MSM-147-16 and GSP/MSM-148-16; proximal right tibia biconvex lense shaped GSP/MSM-73-16; left and right proximal fibulae GSP/MSM-76-16 and GSP/MSM-77-16; convex part of sternal GSP/MSM-1014-16; sternal part GSP/MSM-604-16; part of ilium GSP/MSM-557-16; part of neural spine or armor spine with wound mark GSP/MSM-150-16; vertebral process/neural spine GSP/MSM-391-16; cervical ribs GSP/MSM-328-16, GSP/MSM-329-16; neural spine GSP/MSM-767-16; mosaic type osteoderms GSP/MSM-83-16, GSP/MSM-1035-16. (**Figure 6** & **Figure 7**).
Holotypic elements	33	31*	1	33
Type locality	Alam (central Alam) (latitude 29˚41'0.7"N; longitude 69˚23'58"E; Figure 4 of [88]).	*central Alam	Upper Sangiali or South Sangiali (Figure 4 of [88]) latitude 29.69809N and longitude 69.39882E.	Top Kinwa (Figure 4 of [88]), at latitude 29.68809 N and longitude 69.4002 E (N 29˚41'17.60"; E 69˚24'0.72") of Pakistan.

Continued

Referred specimens	Postzygapophyses GSP/MSM-638-19c from Alam type locality; Neural arch of anterior-mid dorsal vertebra GSP/MSM-82-4; anterior caudal vertebra GSP/MSM-36-4; mid caudal vertebrae GSP/MSM-37-4, GSP/MSM-38-4, GSP/MSM-39-4, and GSP/MSM-39(a)-4; mid scapular blade with ridge GSP/MSM-838-4; right mid and proximal scapula GSP/MSM-198-4; proximal and mid femur GSP/MSM-208-4; and osteoderm ellipsoidal plate GSP/MSM-85-4 from south Kinwa. Proximal tibia GSP/MSM-181-2 and proximal tibial shaft GSP/MSM-850-2 from east Bor, Pakistan (Figure 11). Distal right slender femur GSP/MSM-71-15 (Figure 17) from southern Mari Bohri, referred on basis of slenderness and size (Pakistan). A caudal vertebra K20/317 and a humerus from Bara Simla India [94] and right and left humeri, right radius, left femur, left tibia and left fibula of Chhota Simla limb skeleton [96] [97] from India were referred [84] [89].	*Same as *Gspsaurus pakistani*	Proximal humerus GSP/MSM-237-10 (Figure 13 of [54]) from Rahi Wali. 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 from Grut (Figure 1 of [89]); Anterior caudal vertebra GSP/MSM-49-16 from Top Kinwa (north western corner of Top Kinwa); anterior caudal vertebrae GSP/MSM-50-4 and GSP/MSM-51-4 from south Kinwa.; Chevron GSP/MSM-321-13 from east Dolwahi; sub oval armour bone (GSP/MSM-1095-17) from Dada Pahi 17 locality (Figure 1 of [89]), Pakistan (Figure 12). Some vertebrae and limb bones from upper Sangiali locality of Pakistan observed in the field and not collected from Pakistan. Referred right and left humeri (78cm length) GSI type no 20010 (Figures 1a, b, of Plate 1 of [94]) and GSI 20011 [94] reported from Rahioli locality, Gujarat state, India were referred [54].	-
Referred Elements	13 elements from Pakistan; 8 elements from India. 13 + 8 = 21	*Same as *Gspsaurus*	13 + 2 = 15	-
Referred localities	East Bor 2 and South Kinwa 4 and southern Mari Bohri (Figure 4 of [88]) from Pakistan. Chhota Simla [96] [97] and Bara Simla [93] localities of Jabalpur, central India and Rahioli [94] locality of Gujarat state of western India.	*Same as *Gspsaurus*	Grut 9, Rahi Wali 10 (Rahiwali), east Dolvahi 13 (Figure 1 of [89]), Dada Pahi 17 and east Alam 18 (Figure 4 of [89]), Pakistan. Rahioli [94], Gujarat, western India.	-
Total holotypic and referral elements	33 + 21 = 54	*52	1 + 15 = 16	33
Total Individuals	5	*5	8	1
Horizon/Formation	Vitakri Formation; Lameta Formation	Vitakri Formation; Lameta Formation	Vitakri Formation. Lameta Formation	Vitakri Formation
Age	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 Range; Sulaiman Basin) (Pakistan). Rahioli, Gujarat (western India)	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin) (Pakistan).

Table 9. Statistical data and basic information of Saraikimasoomidae Poripuchian titanosaurs (Sauropoda, Dinosauria) found from the Late Cretaceous Vitakri Formation of Pakistan.

Titles	*Saraikimasoom vitakri*	*Nicksaurus razashahi*
Informal Description	[79]	[79]
Formal Description	[88]	[89]
Holotype	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. (Figure 13, Figure 14)	Jaw ramus with 6 teeth GSP/MSM-138-4n; proximal maxilla with 2 or 3 teeth GSP/MSM-315-4n; maxilla/skull element with 1 tooth GSP/MSM-314-4n; cervical vertebrae GSP/MSM-381-4n, GSP/MSM-383-4n and GSP/MSM-212-4n; dorsal vertebra GSP/MSM-382-4n; caudal vertebrae GSP/MSM-347-4n, GSP/MSM-348-4n; caudal chevron GSP/MSM-313-4n; proximal scapula GSP/MSM-1096-4n; mid scapular parts GSP/MSM-380-4n and GSP/MSM-377-4n; left humerus GSP/MSM-438-4n; proximal radius GSP/MSM-344-4n; left femur GSP/MSM-190-4n; right distal femur GSP/MSM-192-4n; right femur parts GSP/MSM-378-4n, GSP/MSM-270-4n; left and right distal tibiae GSP/MSM-346-4n, GSP/MSM-345-4n; tibia shaft cross section GSP/MSM-379-4n (Figure 15)
Holotypic elements	1	22
Type locality	South Kinwa* (latitude 29˚40'57"N; longitude 69˚23'09"E; Figure 4 of [88])	North Kinwa (latitude 29˚41'16"N; longitude 69˚23'31"E; Figure 4 of [88])
Referred specimens	-	Caudal vertebrae GSP/MSM-512-4, GSP/MSM-514-4, GSP/MSM-811-4, GSP/MSM-515-4 and GSP/MSM-808-4 from south Kinwa. Caudal vertebrae GSP/MSM-1021-4m (north), GSP/MSM-1018-4m (north) and GSP/MSM-1019-4m (north), broad anterior caudal vertebra GSP/MSM-1016-4m and midcaudal vertebra GSP/MSM-1017-4m-south from mid Kinwa.. Five spongy coprolite/osteoderms GSP/MSM-1050, GSP/MSM-1051, GSP/MSM-1052, GSP/MSM-1053 and GSP/MSM-1054 from Vitakri dome. A few teeth or rock fragments. A distal rib MSM-5/02 Karkh from south Karkh locality (Figure 1 of [89]) (first Maastrichtian titanosaur bone from Kirthar basin/lower Indus basin). (Figure 15).
Referred Elements	-	18
Referred localities	-	south Karkh (Figure 1 of [89]). South Kinwa and mid Kinwa (Figure 4 of [88]), Vitakri dome (Figure 4 of [88]).

Continued

Total holotypic and referral elements	1	22 + 18 = 40
Total Individuals	1	5
Horizon/Formation	Vitakri Formation	Vitakri Formation
Age	Latest Maastrichtian	Latest Maastrichtian
Distribution Territory; (Basin) wise	Barkhan District, Balochistan Province; (Sulaiman Basin, Pakistan)	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin, Pakistan)

Table 10. Statistical data and basic information of Balochisauridae Poripuchian titanosaurs (Sauropoda, Dinosauria) found from the latest Cretaceous (latest Maastrichtian) of Pakistan.

Titles	*Balochisaurus malkani*	*Marisaurus jeffi*	*Qaikshaheen masoomniazi*
Informal Description	[68]	[68]	-
Formal Description	[89]	[89]	[54]
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; first biconvex caudal vertebra GSP/MSM-43-15, anterior-mid caudal vertebrae GSP/MSM-44-15, GSP/MSM-44a-15, GSP/MSM-45-15 to GSP/MSM-48-15, mid caudal vertebrae GSP/MSM-260-15, GSP/MSM-505-15, distal caudal vertebra GSP/MSM-834-15; cervical rib GSP/MSM-881-15; caudal neural arch GSP/MSM-324-15; distal caudal neural arch without neural spine GSP/MSM-325-15, distal rib/neural spine GSP/MSM-672-15, chevron part GSP/MSM-1056-15; proximal thoracic rib GSP/MSM-322-15; mid part of thoracic 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 ulna GSP/MSM-227-15. (**Figure 16**, **Figure 17**)	Biconvex first caudal GSP/MSM-7-15; anterior caudal vertebra GSP/MSM-29-15; mid-caudal vertebrae GSP/MSM-33-15, GSP/MSM-815-15 and GSP/MSM-808-15; distal caudal neural arch 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) (**Figure 18**).	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. (Figure 11 of [54]).
Holotypic elements	35	14	22
Type locality	Mari Bohri (latitude 29˚41'57"N; longitude 69˚14'59"E; Figure 4 of [88])	Mari Bohri (latitude 29˚42'08"N; longitude 69˚15'08"E; Figure 4 of [88])	Mid Sangiali (10m long and 5m wide area bounded by latitudes 29.69810N and 29.69812N and longitudes 69.39872E and 69.39882E) (Figure 4 of [88]).
Referred specimens	Proximal right femora GSP/MSM-749-15 and GSP/MSM-167-15 and distal left femur GSP/MSM-170-15 (**Figure 17**) from south Mari Bohri (Figure 4 of [88]).	Type series Caudal vertebrae GSP/MSM-15-15, caudal vertebra GSP/MSM-23-15, GSP/MSM-24-15, GSP/MSM-25-15 and GSP/MSM-26-15 from Mari Bohri; A coracoid GSP/MSM-742-8, dorsal vertebra GSP/MSM-134-8 and caudal vertebra GSP/MSM-40-8 from Darwaza (**Figure 18**).	Cervical vertebra GSP/MSM-359-2, cervicodorsal vertebra GSP/MSM-120-2, dorsal vertebrae GSP/MSM-121-2, GSP/MSM-122-2, GSP/MSM-124-2, GSP/MSM-125-2, GSP/MSM-441-2, neural arch of dorsal vertebra GSP/MSM-123-2, a pair of sacral vertebrae GSP/MSM-135-2, caudal vertebrae GSP/MSM-41-2 and GSP/MSM-42-2, GSP/MSM-360-2, distal part of cervical rib GSP/MSM-187-2, distal thoracic rib GSP/MSM-301-2, dorsal neural arch with postzygapophyses GSP/MSM-792-2, distal rib/neural spine GSP/MSM-784-2, prezygapophyses and postzygapophyses GSP/MSM-560-2; distal caudal neural arch without developed neural spine GSP/MSM-302-2, 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 mid Bor, Pakistan (Figure 12 of [54]). A right humerus (Figure 2a, b, of Plate V [93]) from Bara Simla, India and a right humerus of 85 cm length (GSI 20012, Figure 4 of Plate 1 of [94]) 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 [90]). A femur GSI/WR/M/90/84 from Rahioli locality [92] [94] [95] 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 [90], and distal femur GSP/MSM-1-1) from Pakistan [54].

Continued

Referred Elements	4	8	50 (+49 Miscellaneous pieces from Sangiali)
Referred localities	south Mari Bohri 15 (Figure 4 of [88] from Pakistan.	North Mari Bohri type locality area (Figure 4 of [88]); Darwaza (Figure 1 of [89])	Mid Bor (Figure 4 of [88]) from Pakistan. Rahioli locality of Gujarat [94] and Bara Simla [93] locality of Jabalpur India.
Total holotypic and referral elements	35 + 4 = 39	14 + 8 = 22	22 + 50 = 72 (+ 49 miscellaneous pieces)
Total Individuals	3	2	5
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.

Snout, Dentaries and posterior skull: Its snout (**Figure 8**, **Figure 9**) is large than snout of *Saraikimasoom vitakri* (**Figure 13**, **Figure 14**). Its upper jaw and teeth arcade are U-shaped like *Saraikimasoom vitakri*. Its lower jaw/dentary teeth arcade is V-shaped, while *Saraikimasoom vitakri* from Pakistan and *Mansourasaurus shahinae* [100] from northern Egypt, Africa show U-shaped lower teeth row. Its teeth are slender and larger than *Saraikimasoom vitakri* and *Nicksaurus razashahi* teeth. Its dentary ramus is thick and deep like *Khanazeem saraikistani* (**Figure 21**), while *Saraikimasoom vitakri* has relatively thin and shallow dentary ramus. Its snout and partial skull elements are pneumatic like *Saraikimasoom vitakri*, *Nicksaurus razashahi* and *Khanazeem saraikistani*. Its dentary rami lack prominent fibrous/ridges on lateral side, while *Khanazeem saraikistani* has coarse, thick and subparallel elongated ridges oriented anteroposteriorly. Its teeth are moderately spaced with each other (**Figure 8**, **Figure 9**), while *Saraikimasoom* and *Nicksaurus* have closely contacted teeth (**Figures 13-15**), and *Khanazeem saraikistani* has wide space between teeth (**Figure 21**).

Vertebrae: Its reported vertebrae mostly represent centra, while numerous neural arches are found with this assemblage (now found in GSP museum, but not documented so far). These vertebrae are also described [74] and its measurements are shown in Tables 1-3 of [74]. Cervicals are opisthocoelous, pneumatic and broad. Centra of anterior cervicals are small while centra of mid cervical are large and then centra of posterior cervical are moderate in size. Its parapophysis are located posterolateral part in anterior cervicals and shifting anteriorly as series go posteriorly. Its mid neck is heavy, stocky and strongly broad transversely. Centra of dorsal vertebrae are broad, pneumatic and opisthocoelous (**Figure 10**). Dorsal vertebral neural arch (GSP/MSM-82-4) from south Kinwa consists of partial neural spine, diapophysis, prezygapophyses, postzygapophyses neural canal and surrounding areas. This was previously reported as atlas-axis complex, now identified dorsal neural arch (verbal communication and discussion with Dr. Jeffrey A. Wilson Mantilla regarding our running collaborative report). Another similarly portion of neural arch is also reported for *Qaikshaheen masoomniazi* neural arch GSP/MSM-123-2 found from mid Bor (see below). This south Kinwa neural arch belongs to mid or posterior dorsal

Table 11. Statistical data and basic information of Pakisauridae Poripuchian titanosaurs (Sauropoda, Dinosauria) found from the Late Cretaceous (latest Maastrichtian) from Pakistan.

Titles	*Pakisaurus balochistani*	*Sulaimanisaurus gingerichi*	*Khetranisaurus barkhani*	*Khanazeem saraikistani*	*Imrankhanhero zilefatmi*
Informal Description	[68]	[68]	[68]	-	-
Formal Description	[88]	[88]	[88]	[90]	[54]
Holotype	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 and GSP/MSM-810-4; cervicodorsal vertebra GSP/MSM-133-4; dorsal vertebra GSP/MSM-1011-4; partial sacrum GSPMSM-136-4; GSP/MSM-1008-4; anterior caudal vertebrae GSP/MSM-11-4 and GSP/MSM-207-4; mid-caudal vertebrae GSP/MSM-12-4,GSP/MSM-13-4, GSP/MSM-14-4, a, GSP/MSM-763-4, GSP/MSM-1010-4; cervical neural spine GSP/MSM-601-4; partial neural arches of dorsal and caudals GSP/MSM-804-4, GSP/MSM-805-4, GSP/MSM-878-4, and GSP/MSM-878a-4; distal caudal neural arch GSP/MSM-519-4, partial right and left scapulae (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 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; 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 (**Figure 19**).	Anterior caudal vertebrae GSP/MSM-17(a)-4, GSP/MSM-18-4, GSP/MSM-19-4, GSP/MSM-20-4; mid caudal vertebrae GSP/MSM-21-4, GSP/MSM-21(a)-4, GSP/MSM-22-4 (Figure 5 of [88]) and (Figures 5-8 of [70]).	Caudal vertebrae GSP/MSM-27-4, GSP/MSM-28-4 (Figure 5 of [88]) and (Figures 5-8 of [70]).	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; proximal right humerus GSP/MSM-180-2; proximal left humerus GSP/ MSM-288-2, mid of right 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 (**Figure 21**) (Figure 4 of [90]).	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 (Figure 10 of [54]). (**Figure 22**)
Holotypic elements	**56**	**7**	**2**	**14**	**4**
Type locality	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) (Fig. 4 of [88])	South Kinwa (Southernmost Kinwa) (latitude 29˚40'54"N; longitude 69˚23'04"E) (Fig. 4 of [88])	Mid Kinwa (latitude 29˚41'04"N; longitude 69˚23'17"E) (Fig. 4 of [88])	Lower Bor (Fig. 4 of [88]) at Latitude 29.68700 and Longitude 69.3771 (N 29˚41'12" and E 69˚22'37") (Figure 4 of [90])	Lower Sangiali or north Sangiali (Fig. 4 of [88]) latitude 29.69812N and longitude 69.39860E.
Referred specimens	Parietal (with few teeth on its surface) GSP/MSM-353-4; proximal scapula GSP/MSM-335-4; mid scapula GSP/MSM-267-4; scapular part GSP/MSM-678-4; proximal right humerus GSP/MSM-195-4 found from south Kinwa. Partial acetabulum GSP/MSM-403-19n; proximal radius GSP/MSM-756-19n; distal ulna GSP/MSM-628-19n; and dorsal vertebra GSP/MSM-758-19n from north Alam. Fractured distal caudal vertebra GSP/MSM-523-3; distal caudal vertebra with horizontal groove on posterior cone GSP/MSM-151-3; Caudal vertebra GSP/MSM-23-3; neural arch of distal caudal with GSP/MSM-521-3; coracoid GSP/MSM-366-3; ulna GSP/MSM-748-3; ungual GSP/MSM-152-3; and spongy thick armour spine GSP/MSM-150-3 from Shalghara, Pakistan (**Figure 20**). Right and left humeri of 70 cm length from Rahioli Gujarat India area (GSI type no 20008, Plate 1, Figure 3 of [94]; GSI 20009; Plate 1, Figure 2 of [94]) were referred from India [90].		One vertebra like holotype was found on mid Kinwa (just west of foot track) and other bones (mostly caudal vertebrae and limb bones).	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, proximal ulna GSP/MSM-1032-16 (Figure 4 of [90]) from Top Kinwa (Fig. 4 of [88]), Pakistan. (**Figure 21**) A femur from Rahioli, western India (ISI 622-623-624; Bandyopadhyay, pers. communication with Jeffrey A. Wilson; [92]) was referred, which possesses the slender proportions, proximolateral profile and inflected head present in lower Bor left and right femora [90].	Flattened tibia GSP/MSM-235-7; fibula GSP/MSM-253-7; and metatarsal GSP/MSM-296-7 (Figure 10 of [54]) (**Figure 22**); Caudal vertebrae GSP/MSM-523-7 and GSP/MSM-524-7; scapula GSP/MSM-746-7; and osteoderm GSP/MSM-84-7 from south Zubra; Pakistan. (**Figure 22**) Further referred tibia K 20/321 (Figures 4a, b, of Plate 1 of [93]) and right fibula K 27/489 (Figures 5a, b, of Plate 1 of [93]) from Bara Simla, India were referred to *Imrankhanhero zilefatmi* due to shape resembling with its South Zubra exemplar's tibia and fibula.
Referred Elements	17 + 2 = 19		-	6 + 1 = 7	7 + 2 = 9
Referred localities	North Alam 19, Shalghara 3, South Kinwa 4/4s, (Fig. 4 of [88]), from Pakistan, and Rahioli Gujarat, western India [94].		Mid Kinwa 4 or 4 m (Fig. 4 of [88])	Top Kinwa 16 (Fig. 4 of [88]) from Pakistan [90], and Rahioli, Gujarat, western India [90] [92].	Zubra peak and south Zubra 7 (Fig. 1 of [89]) (latitude 29˚43'12"N; longitude 69˚30'16"E) from Pakistan. Bara Simla [93] from India.
Total holotypic and referral elements	56 + 19 = 75	7	2	14 + 7 = 21	4 + 9 = 13
Total Individuals	5	1	1	3	3

Continued

Horizon/Formation	Vitakri Formation; Lameta Formation	Vitakri Formation	Vitakri Formation	Vitakri Formation; Lameta 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).	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin)	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin). Rahioli, western India	Barkhan District, Balochistan Province; (Sulaiman Range; Sulaiman Basin). Bara Simla, central India.

vertebrae because of its close position to plane of symmetry. Its preserved diapophysis is arc shaped and laterally occurring. Its prezygapophysis is triangular shaped while postzygapophysis is relatively large and subrectangle shaped? It is pneumatic and has many well preserved elongated coels and laminae in anterior, lateral, posterior and dorsal views (Figure 11). An infraprezygapophyseal lamina goes from prezygapophyses to the sides of neural canal. Another lamina runs from prezygapophysis to diapophysis. A lamina between the left and right prezygapophysis is also found. Further an arc shaped lamina started from the laterodorsal part of centrum and run toward parapophysis (Figure 11). Its neural canal is slightly broad transversely. Its neural spine is slightly broad transversely (Figure 11). Its neural spine is transversely broad and expanded at summit (Figure 11), while *Qaikshaheen masoomniazi* has squat profile, *Balochisaurus malkani* has short spine and *Isisaurus colberti* spine is dorsoventrally long [101]. Caudals found positioned in anterior (known by well developed transverse process; (Figure 11), mid and posterior series. Caudals are procoelous and neural arch migrated anteriorly. The transverse process of slightly broad anterior caudals extends downward upto mid centrum. Its anterior caudals are slightly broad. Mid caudal centra are slightly tall with somewhat ventral reduction but ventral reduction is less than *Balochisaurus*, *Qaikshaheen* and *Nicksaurus*. Its mid caudals have subcircular prezygapophysis. Its postzygapophysis are laterally facing. Its broad anterior caudal has very broad neural canal, while mid caudals have subcircular neural canal. Its mid and posterior caudals have restricted posterior articular condyle. Its distal caudals are cylindrical shape. Its caudal centra are similar to vertebral series of *Alamosaurus* [102].

Scapula: It's left and right proximal scapula especially the glenoid area (Figure 10) is robust like *Imrankhanshaheen masoombushrai*, while *Marisaurus jeffi* has more robust proximal scapula, and *Pakisaurus balochistani* has slender proximal scapula. Its proximal scapula is almost straight with respect to mid scapula (Figure 11) like *Imrankhanhero zilefatmi*, while *Pakisaurus balochistani* has outwardly or laterally directed proximal scapula. Its mid scapula show ventral ridge (Figure 11).

Radius: Its proximal radius has relatively more prominent depression (in dorsal view) (Figure 10) like *Pakisaurus balochistani* (Figure 20), while *Nicksaurus razashahi* has feeble dorsal depression (Figure 15). Its proximal radius is slender and gracile, while *Nicksaurus razashahi* and *Pakisaurus balochistani* have robust proximal radius. It is elongated oval shape. It's one pole (may be posteromedial) is thick while another pole is narrow and rounded, while *Nicksaurus razashahi* and *Pakisaurus balochistani* have thick pole and another less narrow and rounded pole. Its medial or lateral views show strong expansion of proximal end, while *Nicksaurus razashahi* and *Pakisaurus balochistani* have relatively less expansion of proximal end. On lateral view it's both poles also show more outward bending with respect to shaft, while *Nicksaurus* and *Pakisaurus* have relatively less outer bending on narrow pole and very slight bending on thick pole. Proximal end of radius from Chhota Simla [96] [97] is not sufficiently preserved for comparison, however it shows on both side outward bending and expansion of proximal radius like *Gspsaurus pakistani* radius.

Ilium: The anterior part of iliac blade is preserved. Its lateral side is concave and relatively thin, while medial side is convex medially and more expanded. Its medial convex side has medially extruded thick block (**Figure 10**) which may be connected with sacral ribs. Its anterolateral corner has step (**Figure 10**) from lateral side of iliac blade, while *Isisaurus colberti* [101] and *Pakisaurus balochistani* has no step and continue as same plane. Its ilium is thick like *Pakisaurus balochistani* (**Figure 19**), while *Imrankhanshaheen masoombushrai* has relatively thin ilium (**Figure 7**).

Femur: Proximal and distal femur (**Figure 10**, **Figure 11**) is preserved. Its femur seems to be slender like *Qaikshaheen masoomniazi*, while *Balochisaurus malkani* and *Nicksaurus razashahi* have robust femora, and *Marisaurus jeffi* has more robust femora, *Pakisaurus balochistani*, *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have more slender femora. The Chhota Simla femur [96] [97] is also slender like holotypic femur of *Gspsaurus pakistani*.

Tibia: Its proximal and distal tibiae are preserved (**Figure 10**). Its dorsal view of proximal end is subrectangular with anteroposteriorly more broad than transverse width. Its anteroposterior width is about 1.3 times of transverse width (**Figure 11**), while *Balochisaurus malkani* and *Qaikshaheen masoomniazi* have proximal tibia with subequal anteroposterior and transverse width (**Figure 17**), and *Khanazeem saraikistani* (**Figure 21**) and *Imrankhanhero zilefatmi* have slender tibiae with anteroposterior width is about twice or more of transverse width of proximal tibia. Its proximal tibia is robust while *Balochisaurus malkani* and *Qaikshaheen masoomniazi* have more robust and *khanazeem saraikistani* and *Imrankhanhero zilefatmi* have slender tibiae. Its distal tibia is transversely expanded with small astragalous fossa just front of short process like *Nicksaurus razashahi* and *Ikqaumishan smqureshi*, while *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have large astragalous fossa situated in between the two processes. Its distal tibia is transversely broad like *Nicksaurus razashahi* and *Ikqaumishan smqureshi*, while *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have more anteroposteriorly broad distal tibia. Its tibia is robust, while *Balochisaurus* and *Qaikshaheen masoomniazi* have more robust tibia and *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have slender tibiae.

Osteoderm: It has large osteodermal ellipsoid with median cut (**Figure 11**) and resemble with titanosaur (plate 77 of [103]) (Figure 4 of [104]) from Argentina, South America (show paleobiogeographic link), while *Imrankhanhero zilefatmi* from Pakistan, South Asia and *Malawisaurus* [105] of Malawi, Africa also have large ellipsoidal osteodermal plate but without median cut.

2) *Maojandino alami* [80] vide [89]

Its holotype (**Table 8**) (**Figure 10**) is overlapping (same) with postcranial part of holotype of *Gspsaurus pakistani*. *Gspsaurus pakistani* [88] was formally published according to standard set by International Code of Zoological Nomenclature (ICZN) before *Maojandino alami* [89]. So it is a junior synonym of *Gspsaurus pakistani*.

3) *Ikqaumishan smqureshi* [54]

Its holotype is humerus (**Table 8**) (**Figure 12**). It was referred humerus (**Figure 12**) from Rahi Wali. Some vertebrae and other fossils from east Alam were referred to stocky Balochisauridae, now being referred to *Ikqaumishan smqureshi*. Grut locality yielded 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 (**Figure 12**) which are being referred to *Ikqaumishan smqureshi* due to sharing of humerus, fossils sizes are also in agreement, similarity of observed caudals of upper Sangiali and also close occurrence of Rahi Wali humerus (GSP/MSM-237-10) locality. A caudal chevron GSP/MSM-321-13 from east Dolwahi 13 is also being referred to it on close finding with its fossils. Further caudals GSP/MSM-50-4 and GSP/MSM-51-4 of south Kinwa and caudal GSP/MSM-49-16 of northwestern top Kinwa (**Figure 12**) and also observed caudals of east Alam (PDL 18) which are being referred to it because of similarity of caudals with observed caudals of upper Sangiali. Eastern Alam hosts some observed vertebral and appendicular assemblage of stocky titanosaur on southern slope of north eastern portion (page 70 of [75]) which are being referred to it because of caudal shape similarity. East Alam locality is about 200 - 300 m southeast of Top Kinwa 16 and North Alam 19n. Further a sub oval armour bone GSP/MSM-1095-17 from Dada Pahi locality is being referred due to close occurrence of east Alam assemblage of *Ikqaumishan smqureshi*. Its basic data are shown in (**Table 8**). Referred fossils are briefly described as below. Most of these caudals belong to proximal part of caudal series due to well developed transverse process. Its caudals are procoelous and somewhat ventrally reduced. Its caudal chevron is anteroposteriorly compressed like *Nicksaurus*, while *Khanazeem* has transversely compressed. Its referred humerus has well developed robust head. Its distal ulna is divided and broad concavity on one side and convexity on another side. It has rugosities on the ventral view. *Ikqaumishan* distal tibia is expanded transversely, astragalar fossa is relatively small and located in front of its short process (**Figure 12**) like those of *Gspsaurus* and *Nicksaurus* distal tibiae and differ from those of *Khanazeem* and *Imrankhanhero* distal tibiae which are expanded anteroposteriorly, astragalar fossa is larger and located in the mid/centre between its long and short processes. An astragalus GSP/MSM-752-9 (**Figure 12**) was collected. The general shape of astragalous is transversely long and concave or syncline type with limbs. The medial and lateral parts are truncated. The astragalus fossa at the base of ascending process is present. Astragalous posterior fossa shape is undivided. The lateral surface of the ascending process is straight inclined downward or mildly convexing profile generally inclining downward. This astragalous body is long and concave transversely. It forms the transversely oriented axis syncline with anterior and posterior limbs. These limbs are named as anterior limb and posterior limb due to their occurrences. The anterior limb convex maximum form ridge in the lateral one third distance from lateral corner. From maximum peak or ridge of ascending process, on both sides laterally and also medially the inclination started toward medial and lateral base. Posterior limb behavior is same as anterior limb but difference is that the posterior limb peak is lower than anterior limb. Both limbs trend transversely separated by an elongated depression or groove which is also oriented transversely. Between the anterior and posterior ridges is a deep astragalous fossa. Further detail description was found in [54]. Its osteoderm GSP/MSM-1095-17 is a relatively thick suboval plate than *Imrankhanshaheen*, while *Gspsaurus* and *Imrankhanhero* have large, very thick ellipsoidal plates. It has mosaic of large ossicles/polygons. It has concavity on one corner (**Figure 12**).

4) *Imrankhanshaheen masoombushrai* new genus and new Species

Systematic Paleontology

Dinosauria; Saurischia; Sauropoda; Titanosauriformes; Titanosauria; Poripuchia [86] vide [88]; Gspsauridae [81] vide [88]; Gspsaurinae [81] vide [88];

Imrankhanshaheen masoombushrai new genus and new species (**Figure 6** & **Figure 7**)

Holotype: Partial braincase (GSP/MSM-2-16 and GSP-UM 7000), dorsal vertebrae GSP/MSM-131-16 and GSP/MSM-132-16, anterior dorsal vertebra GSP/MSM-256-16, dorsal vertebrae with ventral ridge GSP/MSM-774-16 and GSP/MSM-511-16, two coosified sacral vertebrae GSP/MSM-137-16, two coosified sacral vertebrae GSP/MSM-776-16, mid caudal vertebrae GSP/MSM-34-16 and GSP/MSM-35-16, distal caudal vertebra GSP/MSM-153-16, left and right distal scapulae GSP/MSM-250-16 and GSP/MSM-176-16, mid humerus GSP/MSM-468-16, left and right proximal ulna GSP/MSM-175-16 and GSP/MSM-240-16, distal ulna GSP/MSM-74-16, distal radius GSP/MSM-160-16, metacarpal GSP/MSM-1036-16, acetabulum in 2 pieces GSP/MSM-147-16 and GSP/MSM-148-16, proximal right tibia biconvex lense shaped GSP/MSM-73-16, left and right proximal fibulae GSP/MSM-76-16 and GSP/MSM-77-16, convex part of sternal GSP/MSM-1014-16, sternal part GSP/MSM-604-16, part of ilia GSP/MSM-557-16, neural spine/osteoderm with wound mark GSP/MSM-150-16, vertebral process/distal spine GSP/MSM-391-16, distal cervical ribs GSP/MSM-328-16, GSP/MSM-329-16, neural spine GSP/MSM-767-16, two mosaic type osteoderm GSP/

MSM-83-16, GSP/MSM-1035-16 (**Figure 6**, **Figure 7**) found from Top Kinwa (**Table 8**). This holotypic assemblage found on surface (10 m × 5 m area) at the same time, single site, size matches (size agreement among holotypic elements) and no duplication among these holotypic elements, show association of a single individual. Holotypic braincase is found in the southwest corner while proximal tibia is found on the northeast corner while other bones are found mostly in between of these two locations. Holotypic fossil is housed in the museum of Geological Survey of Pakistan, Quetta, Pakistan. Cast number UMMP 11303 of braincase (GSP/MSM-2-16; GSP-UM 7000) is present in the Museum of Paleontology, University of Michigan.

Type locality, horizon and age: Holotype was found in the Topkinwa (Top Kinwa or eastern Kinwa) type locality (Pakistan dinosaur locality 16; shown in Figure 4 of [88]) at latitude 29.68809 N and longitude 69.4002 E (N 29˚41'17.60"; E 69˚24'0.72") of Vitakri dome area, Barkhan district, Balochistan Province, Pakistan. This holotype is found a few meters west of dividing line between the Kinwa stream and Alam stream. Host horizon of holotype is the upper shale unit (**Figure 1**) caped by upper sandstone unit of Vitakri Formation (Table 1 of [90]) of Fort Munro Group [62] [63]. 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 Late Cretaceous, more specifically latest Maastrichtian 67 - 66 Ma ([17] pages 903-906, [73] [75] [88] [89]). This type locality also yielded holotypes of mesoeucrocodile *Pabwehshi pakistanensis* [98] and pterosaur *Saraikisaurus minhui* [88].

Etymology: The genus name *Imrankhanshaheen* honors the winner of world cup and Former Prime Minister of Pakistan Imran Khan and great journalist Imran Khan to support poor peoples of Koh Sulaiman Range and Sulaiman Basin of Pakistan which is the host of these fossils, and *Shaheen*, Saraiki for king. The genus name *Imrankhanshaheen* can be pronunciated as Imran Khan Shaheen. The species name *Imrankhanshaheen masoombushrai* is after the *masoom*, Saraiki language for innocent, *bushrai*, to honor the former first lady respected Bushra Bibi (wife of Former Prime Minister of Pakistan Imran Ahmad Khan Niazi). The species name *Imrankhanshaheen masoombushrai* can be pronunciated as masoom bushrai.

Diagnosis: *Imrankhanshaheen masoombushrai* medium sized sauropod shares with the Titanosauria on the basis of procoelous caudal vertebrae with anteriorly set neural arch and prominent olecranon process of ulna. It shares with more/most derived forms as mid caudal centra with a ventral longitudinal hollow while posterior caudal lack this feature. It shares with Poripuchia being procoelous distal caudal. It shares with Gspsaurinae Gspsaurid on the basis of robust tibia (anteroposterior width is round about 1.3 time of transverse width) and somewhat ventrally reduced mid-caudals. Its diagnosis and comparisons are as follows as. *Imrankhanshaheen masoombushrai* has small braincase with broad occipital condyle. Its braincase has a prominent supraoccipital wedge and proatlantal facets. Its occipital condyle is deflected ventrally and occipital condyle facing posteroventrally (**Figure 6**) like Dongargaon braincase ISI R199 [106] and Rahioli braincase ISI R467 [107] from latest Cretaceous of India, *Bonatitan reigi* [108] [109] and *Antarctosaurus* (MACN 6904; [103] [110] from Argentina, South America and *Nemegtosaurus* [111] from Late Cretaceous of Mongolia, Asia, while in contrast *Jainosaurus* Bara Simla braincase (GSI K27/497; [93], fig. 5) and Bara Simla Jabalpur braincase ISI R162 [107] from latest Cretaceous of India, *Vahiny Depereti* [112] from Late Cretaceous of Madagascar, *Malawisaurus* [105] from Malawi, Africa, *Saltasaurus* PVL 4017 [103], *Muyelensaurus* [113] and *Puekunsaurus* [114], *Kaijutitan maui* [115] from Argentina, South America, *Quaesitosaurus* [116] from Late Cretaceous of Mongolia, Asia and *Phuwiangosaurus sirindhornai* [117] from early Cretaceous of Thailand, Asia show occipital condyle parallel to skull roof.

Its broad supraocipital wedge is prominent (**Figure 6**) like Dongargaon braincase ISI R199 [106] and Rahioli braincase ISI R467 [107] from India, *Bonatitan reigi* [108] [109] from Argentina. Its small circular proatlantal facets on exoccipital is prominent like Dongargaon braincase ISI R199 [106] from India, and *Bonatitan reigi* [108] [109] from Argentina, while in contrast Rahioli braincase ISI R467 [107] from India has no this feature. Its supraoccipital has no prominent groove along the median suture like Rahioli braincase ISI R467 [107] from India, while Dongargaon braincase ISI R199 [106] from India and *Bonatitan reigi* [108] [109] from Argentina, both have prominent groove along median suture of both fellows. Its braincase has well developed longitudinal depression on the lateral flanks of supraoccipital wedge like *Bonatitan reigi* [108] [109] from Argentina, while Rahioli braincase ISI R467 [107] and Dongargaon braincase ISI R199 [106] from India have no such well developed depressions. Its braincase has well developed depression just on the anterior of proatlantal facets, while this depression is not found in the braincase of *Bonatitan reigi* [108] [109] from Argentina, Rahioli braincase ISI R467 [107] and Dongargaon braincase ISI R199 [106] from India. Its braincase has feeble sutures of different elements like those of *Bonatitan reigi* [108] [109] from Argentina, while Dongargaon braincase ISI R199 [106] from India has well developed sutures in different elements. Its braincase has dorsoventrally elongated subrectangular shaped with little convex in the central lateral width, while the foramen magnum of Dongargaon braincase ISI R199 [106] from India has well developed vaulted door shape and Rahioli braincase ISI R467 [107] from India has well developed oval shape elongated dorsoventrally.

The braincase of *Imrankhanshaheen masoombushrai* has II, III and V nerves forming compositely straight line (**Figure 6**) like those of Dongargaon braincase ISI R199 [106] India, while Rahioli braincase ISI R467 [107] from India has well developed arc shaped (medium to tight anticline shaped) these nerves composite line and the braincase of *Bonatitan reigi* [108] [109] from Argentina has feeble arc shaped (broad anticline shaped) these nerves composite line. Its cranial nerve III shape is subrectangle, while Dongargaon braincase ISI R199 [106] and Rahioli braincase ISI R467 [107] is dorsoventrally longitudinal oval shaped. Its cranial nerve V shape is dorsoventrally longitudinal oval shaped like those of Rahioli braincase ISI R467 [107], while Dongargaon braincase ISI R199 [106] cranial nerve V shape is triangle shape convexing laterally. Its cranial nerves IX-XI shape is large rectangle shape, while Dongargaon braincase ISI R199 [106] cranial nerves IX-X shape is small rectangle shape. Its occipital condyle is strongly broad like Dongargaon braincase ISI R199 [106] and Rahioli braincase ISI R467 [107] from India, while in contrast *Jainosaurus* Bara Simla braincase (GSI K27/497; [93]: fig. 5) and Bara Simla Jabalpur braincase ISI R162 [107] show strongly less broadness. Its occipital condyle base is broad like those of Dongargaon braincase ISI R199 [106], while Rahioli braincase ISI R467 [107] form sharp convexing downward shape in posterior view.

Its cervical centra transverse width is about one and half of dorsoventral height of centrum (**Figure 7**), while *Gspsaurus pakistani* have cervical transverse breadth about 1.3 - 1.4 time of dorsoventral width, *Nicksaurus razashahi* has cervical centra transverse breadth is strongly more than 1.5 time of dorsoventral height, and *Isisaurus colberti* has cervical breadth about 1.3 time of dorsoventral width. Its cervical centrum size is small like *Qaikshaheen masoomniazi*, *Balochisaurus malkani* and *Pakisaurus balochistani*, while *Nicksaurus razashahi* has smallest size, *Isisaurus colberti* is moderate in size and *Gspsaurus pakistani* have largest size among Pakistani titanosaurs. Its cervical pleurocoel is short subrectangle shape. Its anterior dorsal centra are broad, pneumatic with short oval shaped pleurocoel. Its mid-posterior dorsal centra are tall with ventral keel/ridge. Sacral vertebrae are coosified, broad and has ventral keel. Mid caudal is somewhat ventrally reduced, heavy and have subcircular parapophysis and oval shaped postzygapophysis. The distal caudal is long cylindrical and has suboval shaped parapophysis (**Figure 7**).

Its sternal has medial convexity. Its proximal scapula is robust like *Gspsaurus pakistani* and *Qaikshaheen masoomniazi*, while *Marisaurus jeffi* have more robust and *Pakisaurus balochistani* has slender proximal scapula. Its lateral ray/process of proximal ulna is slender and has depression on dorsal view. Its lateral ray end of proximal ulna has rounded edge, while *Balochisaurus malkani* has sharp blady edge. Its distal radius is beveled medially like those of *Pakisaurus balochistani* radius. Its distal radius has a dorsoventrally groove in the median side. Its distal radius has mud crack type rugosities. Its metacarpal end is strongly expanded, while *Qaikshaheen masoomniazi* has moderate expanded end and *Imrankhanhero zilefatmi* has slightly expanded metacarpal end. Its acetabulum glenoid surface has prominent subparallel anteroposteriorly elongated fibrous structure, while *Balochisaurus malkani* and *Pakisaurus balochistani* lacks or have feeble these structures. The acetabular pubic peduncle is thick and triangular shaped while ischial peduncle is relatively thin and platy. *Imrankhanshaheen masoombushrai* acetabular pubic peduncle is triangular shaped (about

45˚ angles from both end of base), while *Balochisaurus malkani* acetabular pubic peduncle is triangular (about 70˚ and 30˚ angles from both end of base), *Pakisaurus balochistani* acetabular pubic peduncle is long oval shaped and *Isisaurus colberti* has subtriangular (about 20˚ angles from both end at base) [101]. Its ilium is relatively thin plate as compared to *Pakisaurus balochistani* and *Gspsaurus pakistani* ilia. Its proximal tibia is asymmetrical biconvex lense shaped (**Figure 7**), while *Gspsaurus pakistani* has subrectangle shaped (**Figure 11**). In both cases the anteroposterior width is about 1.3 times of transverse width, while *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have anteroposterior width twice of transverse width and *Balochisaurus malkani* and *Qaikshaheen masoomniazi* have subequal anteroposterior and transverse widths. Its fibulae are relatively small and slender to compensate the robust tibia for balancing body weight. Its osteoderms are diverse scute with mud crack type grooves and lense shaped plate having fibrous radial structures originating from outer edge and meets with fellow in the mid (**Figure 7**). Further diagnostic features, comparison and description are as below.

Description of elements

Braincase: Holotypic braincase (GSP/MSM-2-16 and GSP-UM 7000) (**Figure 6**) consists of frontal and parietal (skull roof), supraoccipital, exoccipital-opisthotic, basioccipital, basisphenoid, laterosphenoid, prootic and orbitosphenoid (basicranium) (**Figure 6**). This braincase was found with appendicular assemblage (**Figure 7**) by present author from the eastern extremity or top of Kinwa stream. Its comparison with other relevant sauropod is mentioned above. Its further description can be seen in [69] [85]. The reference [69] has mistyped the braincase from "Rahioli, Gujarat" (ISI R 162) instead of braincase from "Bara Simla Jabalpur" (ISI R 162). The correct is braincase from Bara Simla Jabalpur (ISI R 162) from central India (according to [107]). Further the reference [69] has mistyped the braincase from "Bara Simla" (ISI R 467) instead of braincase from "Rahioli" (ISI R 467). The correct is braincase from Rahioli (Raiholi) (ISI R 467) from western India (according to [107]). The reference [69] has mistyped/miscoordinated that the top Kinwa braincase is found isolated, actually it was found with assemblage mentioned above in the holotype of *Imrankhanshaheen masoombushrai*.

Vertebrae: Its cervical centrum is broad, opisthocoelous and having a relatively short subrectangle shaped pleurocoel. Cervical ribs are V-shaped in the mid and show broad curvature at the end. Its dorsal vertebra is slightly broad showing its position anterior or posterior due to broad cervical and sacral, however the mid dorsal are not broad. Sacral are broad with ventral keel (**Figure 7**). Caudal vertebrae are procoelous, anteriorly migrated neural arch and slightly tall. Its caudals are ventrally reduced but less than *Qaikshaheen masoomniazi* and *Balochisaurus malkani*. It's distal caudal is cylindrical and long with subcircular anterior coel.

Sternal Plate: Its medial and anterior parts are found (**Figure 7**). Its medial part convex medially. Its anterior portion is relatively more thick than medial portions.

Scapula: Left and right proximal scapulae are preserved. Its proximal scapula is robust like *Gspsaurus pakistani* and *Qaikshaheen masoomniazi*, while *Marisaurus jeffi* have more robust and *Pakisaurus balochistani* has slender proximal scapula.

Humerus: Its mid humerus is preserved (**Figure 7**). Its minimum transverse with is 12cm. Its transverse width is almost same as humerei of *Qaikshaheen masoomniazi* and referred Rahi Wali humerus of *Ikqaumishan smqureshi* and broader than that of *Imrankhanhero zilefatmi* and *Ikqaumishan smqureshi*.

Radius: Its distal radius is preserved. It is beveled medially. It shows polygon type rugosities on the ventral surface (**Figure 7**).

Ulna: A pair of proximal ulna (MSM-175-16, MSM-240-16) and a distal ulna MSM-74-16 (**Figure 7**) from Top Kinwa, proximal ulna MSM-271-2 and distal ulna MSM-852-2 from mid-Bor locality were found (**Figure 7**). The proximal ulna is triradiate, rugose and bears a prominent olecranon process. There is a marked concave depression on the proximal lateral side. It has also depression on the medial side also. The posterior side have slight depression and almost smooth. The ulna gradually tapers toward down. Distal ulna is divided and broad concavity on one side and convexity on another side. Distal ulna has rugosities on the ventral view. The lateral ray is slender and has depression on dorsal view. Its lateral ray has rounded edge while *Balochisaurus malkani* has sharp blady edge. Its anterior ray maximum width is about 5 - 6 cm like others found in Pakistan.

Metacarpal: A metacarpal shows rectangle shaped end (**Figure 7**). Its metacarpal end is strongly expanded like *Balochisaurus malkani*, while *Qaikshaheen masoomniazi* has moderate expanded end and *Imrankhanhero zilefatmi* has slightly expanded metacarpal end.

Acetabulum: A partial acetabulum (MSM-147-16, MSM-48-16) (**Figure 7**) were collected. It is arc shaped with well developed glenoid. Its glenoid surface has prominent subparallel anteroposteriorly elongated fibrous structure, while *Balochisaurus malkani* lacks or has feeble these structures. The acetabular pubic peduncle is thick and triangular shaped while ischial peduncle is relatively thin and platy. Its comparison mentioned above.

Ilium: A partial ilium MSM-216-19 (**Figure 7**) was collected. This ilium is relatively thin plate as compared to *Pakisaurus* and *Gspsaurus pakistani* ilia.

Tibia: Its proximal tibia is asymmetrical convex lense shaped while *Gspsaurus pakistani* has subrectangle shaped (**Figure 7**). In both cases the anteroposterior width is about 1.3 times of transverse width, while *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have anteroposterior width twice of transverse width and *Balochisaurus* and *Qaikshaheen masoomniazi* have subequal anteroposterior and transverse widths. The robust tibiae of *Imrankhanshaheen masoomniazi* and *Gspsaurus pakistani* have general similarity with those of *Atsinganosaurus velauciensis* titanosaur from the upper Cretaceous of southern France [118] and *Mendozasaurus neguyelap* titanosaur from the upper Cretaceous of Mendoza Province, Argentina [119] and *Saltasaurus loricatus* from late Cretaceous of

Argentina (plate 45 of [103]).

Fibula: Left and right proximal fibulae (**Figure 7**) have rugosities on proximal part on dorsal view only, while the proximal fibula of *Pakisaurus balochistani* has rugosities on proximal part on dorsal view and dorsoventrally elongated rugosities also extended into adjoining medial and lateral part also. Proximal fibula have medial scar. There is a relatively shallow ridge in the medial scar, starting from close to center of proximal surface and trending obliquely downward. Its fibular diagonal ridge is feeble, while *Pakisaurus balochistani* and *Imrankhanhero zilefatmi* have prominent medial diagonal ridge on proximal fibula. The shaft cross section just below the scar is triangular convexing laterally. Its proximal fibula is relatively small like *Balochisaurus malkani*, while *Imrankhanhero zilefatmi* and *Pakisaurus balochistani* have large proximal fibula. It is noted by [54] that slender fibula is adjusted by robust tibiae, and robust fibula is adjusted by slender tibia to balance heavy body weight.

Osteoderms and armor plates: Two mosaic type armour bones (**Figure 7**). Its subrectangle shape plate has 9 cm diameter and made up of irregularly shaped nodule/polygon ossicles of diameter ranging from half centimeter to 4 centimeters, separated by internal ducts of 1 - 3 mm wide. The second mosaic plate is subrectangular with concavo-convexo shape. A relatively large convex lense shaped plate representing radial thread radiated from end pole and joined at plane of symmetry.

Saraikimasoomidae New Family

Definition: *Saraikimasoom*, *Nicksaurus*, their most recent common ancestor and all of its descendants. Its dental formula is 4-13/9-11. Saraikimasoomidae based on its type genus and species *Saraikimasoom vitakri*. It is represented by U-shaped lower and upper teeth rows, relatively short, slender and tapering toward tip teeth which are contacted closely, while Gspsauridae has V-shaped lower teeth row and U-shaped upper teeth row, relatively long, slender and tapering toward tip teeth which are not contacted closely.

Type and only known species: *Saraikimasoom vitakri*

Type locality, horizon and age: As for type and only species [88].

Diagnosis: as for type and only species [88].

Etymology: *Saraiki*, in honor of Saraiki people and language, *masoom*, Urdu and Saraiki language for innocent.

Included Species: Saraikimasoomidae is represented by *Saraikimasoom vitakri* and *Nicksaurus razashahi* of Saraikimasoominae [81] vide [88].

5) *Saraikimasoom vitakri* [79] vide [88]

Its holotypic specimen (**Figure 13** & **Figure 14**) and other basic data are shown in (**Table 9**). Its snout teeth vary in length from 1 to 2 cm and maximum width 0.3 to 0.5 cm except a few anterior and last teeth. Its dental formula is 4-13/9-11. On lateral view the snout is triangular having about 40˚ anterior slope. It was described well in ([85], pages 383-388). Its pneumatic snout is relatively small than pneumatic snout of *Gspsaurus*. Its lower teeth row is U-Shaped, while *Gspsaurus pakistani* has V-shaped lower teeth row. Its teeth are relatively short like *Nicksaurus razashahi*, while *Gspsaurus pakistani* has long slender teeth. Its teeth are closely contacted with each other, while *Gspsaurus pakistani* from Pakistan and *Rapetosaurus krausei* [120] from Madagascar have moderate space between teeth, and *Khanazeem saraikistani* from Pakistan and *Mansourasaurus shahinae* [100] from northern Egypt, Africa have widely spaced teeth. Its teeth series are becoming shorter as going back, while *Nicksaurus razashahi* has alternating a long and a narrow tooth. Its teeth are gradually tapering toward tip like *Gspsaurus pakistani* and *Khanazeem saraikistani*, while *Titanosaurus rahioliensis* [121] from India has equal diameter of teeth length (except tip).

6) *Nicksaurus razashahi* [79] vide [89]

Its holotypic and referred specimens (**Figure 15**) and basic data are shown in (**Table 9**). Its diagnostic features, comparison and descriptions are presented as below.

Partial skull: Jaw articulated with complete 6 teeth (GSP/MSM-138-4n), partial anterior maxilla (GSP/MSM-315-4n) with articulated 2 or 3 teeth, and mid and posterior maxilla/skull bone with 1 tooth (GSP/MSM-314-4n) were found with postcrania. Its teeth are relatively small and slender (**Figure 15**) like *Saraikimasoom vitakri*, while *Gspsaurus pakistani* has large and slender teeth. Its teeth are closely contacted with each other like *Saraikimasoom vitakri*, while *Gspsaurus pakistani* teeth have moderate space between teeth (**Figure 15**), and *Khanazeem saraikistani* and *Mansourasaurus shahinae* [100] have wide space between teeth (**Figure 15**). Its teeth are tapering toward tip like *Saraikimasoom vitakri* and *Gspsaurus pakistani*, while *Titanosaurus Rahioliensis* [121] and *Rapetosaurus krausei* [120] have equal thickness from base to just before tip. Its larger teeth are alternated by smaller teeth, while this feature is frequently not found in *Saraikimasoom vitakri* and *Gspsaurus pakistani*. Its jaw is pneumatic like *Saraikimasoom vitakri* and *Gspsaurus pakistani* crania.

Vertebrae: Its cervical centra (**Figure 15**) are opisthocoelous, pneumatic and small. Its cervical centra transverse width is strongly more than 1.5 time of dorsoventral height, while all other Indo-Pakistani titanosaur has breadth less than 1.5 times. Its cervical centrum is small in size than all Indo-Pakistani titanosaurs. Its dorsal vertebra is broad centrum. Its distal thoracic rib is massive (not spongy) (**Figure 15**). Its caudals are extremely short than all Indo-Pakistani titanosaurs. Its mid caudals lateral side is slightly concave medially, while *Balochisaurus malkani* and *Qaikshaheen masoomniazi* have more concave. Its caudals show relatively less ventral reduction than *Balochisaurus malkani* and *Qaikshaheen masoomniazi* mid caudals. Its caudals are broad transversely while all Indo-Pakistani titanosaurs lack this feature. Its caudal chevron is anteroposteriorly compressed especially in the middle and upper part while lower part is subcircular. Its caudal chevron is anteroposteriorly compressed like *Ikqaumishan*, while *Khanazeem* chevron is transversely compressed. It may be due to position variation.

Scapula: Its proximal expanded scapula with glenoid (**Figure 15**) is robust like *Gspsaurus pakistani* and *Imrankhanshaheen masoombushrai*, while *Pakisaurus balochistani* has slender scapula and *Marisaurus jeffi* has more robust scapula.

Humerus: Its left humerus is preserved while proximal and distal informative parts are not found (**Figure 15**). Its deltopectoral crest is straight upto preserved portion.

Radius: Its proximal radius has feeble dorsal depression (**Figure 15**), while *Gspsaurus pakistani* (**Figure 10**) and *Pakisaurus balochistani* (**Figure 20**) proximal radii have more prominent depression (in dorsal view). *Nicksaurus razashahi* and *Pakisaurus balochistani* have robust proximal radius, while *Gspsaurus pakistani* proximal radius is slender and gracile. Comparison is seen in description of *Gspsaurus.*

Femur: Its femur is robust like *Balochisaurus malkani*, while *Marisaurus jeffi* femur is more robust, *Qaikshaheen masoomniazi* and *Gspsaurus pakistani* have slender femur and *Pakisaurus balochistani*, *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have more slender femur. Its greater trochanter is more horizontal than greater trochanter of femur of *Balochisaurus malkani*. Its left and right distal femora have gracile, long and more posterior expansion of three posterior processes (radial, tibial and third condyles) than any other titanosaurs from Indo-Pakistan. Its femoral minimum transverse width migrated downward from mid shaft like those of *Balochisaurus* and *Marisaurus*, while in contrast the *Pakisaurus*, *Khanazeem*, *Imrankhanhero*, *Gspsaurus* and *Qaikshaheen* have minimum transverse width at about mid shaft.

Tibia: Its left and right distal tibiae (**Figure 15**) are preserved. *Nicksaurus* distal tibia is expanded transversely, astragalar fossa is relatively small and located in front of its short process (**Figure 15**) like those of *Gspsaurus* and *Ikqaumishan* distal tibiae (**Figure 10**, **Figure 12**) and differ from those of *Khanazeem* and *Imrankhanhero* distal tibiae which are expanded anteroposteriorly, astragalar fossa is larger and located in the mid/centre between its long and short processes (**Figure 21**, **Figure 22**).

Balochisauridae [70] vide [89]

Represented by Balochisaurinae [76] (*Balochisaurus malkani* and *Qaikshaheen masoomniazi*) and *Marisaurinae* [76] (*Marisaurus jeffi*).

7) *Balochisaurus malkani* [68] vide [89]

It's holotypic (**Figure 16** & **Figure 17**) and referred specimens (**Figure 17**) and basic data are mentioned in (**Table 10**). Its holotypic material was found from three sites which are about 20 - 30 m away from each other (previously it was mentioned as 50 m [89], it was estimated and not measured. The northern site yielded a few bones, southern site yielded a complete femur and middle site yielded majority of the bones. Its diagnostic features, comparison and descriptions are as below.

Vertebrae: Only four presacral vertebrae are documented so far, while 15 other partial presacral vertebrae among specimen GSP/MSM-813-15 to GSP/MSM-831-15 are not documented. But it shows a series of vertebrae were found. Further many sacral and presacral vertebrae (of *Balochisaurus*, *Pakisaurus*, *Imrankhanshaheen* and others) were also described [71] and its measurements are shown in Tables 2-4 of [71]. Its cervical centra are broad, opisthocoelous and pneumatic. Its cervical centra are moderate in size like *Imrankhanshaheen masoombushrai* and *Pakisaurus balochistani*, while *Nicksaurus razashahi* has relatively smaller cervicals and *Gspsaurus pakistani* has larger cervicals especially mid cervicals. Its cervical centra transverse width is about one and half of dorsoventral height of centrum like *Imrankhanshaheen masoombushrai*, *Pakisaurus balochistani*, *Gspsaurus pakistani*, while *Nicksaurus razashahi* has breadth strongly more than one and half of dorsoventral height. Its dorsal centra are broad and tall. Its broad dorsal centra belong to anterior dorsal due to broad cervicals (but possibly may be posterior dorsal due to expected broad sacrals). The tall centra belong to mid dorsal series [71]. Its tall dorsal centrum includes long lateral pleurocoel with lipped margin which is not found in any Pakistani titanosaurs. Its neural arch of dorsal vertebra GSP/MSM-324-15 includes neural spines, partial prezygapophyses and postzygapophyses (**Figure 16**). Preserved neural arch GSP/MSM-323-15 (**Figure 16**) of dorsal vertebra consists of complete neural spine left and right postzygapophysis. This neural arch has distinctive short spine or fan shape short neural spine (**Figure 16**), while *Qaikshaheen masoomniazi* [54] has distinct squat profile [54], and *Isisaurus colberti* has dorsoventrally elongated spine [101]. Its postzygapophysis plane is not horizontal but inclined and facing dorsolaterally while the plane of postzygapophysis of *Qaikshaheen masoomniazi* and *Isisaurus colberti* is nearly horizontal and slightly inclined dorsolaterally [54] [101]. Its postzygapophysis is spatulate with slightly more long in its axis toward dorsolateral, while *Qaikshaheen masoomniazi* has elliptical postzygapophysis with length 1.5 times of its width [54], and *Isisaurus colberti* has more elliptical postzygapophysis with length more than 2 times of its width [101]. Its peak summit of neural spine in posterior view forms sharp and narrow peak, while *Qaikshaheen masoomniazi* [54] and *Isisaurus colberti* [101] have broad summit and lack sharp and narrow peak. Its peak summit of neural spine in anterior view forms inclination or slope upto position where prespinal lamina start. Both prespinal and postspinal laminae have same transverse width, while the prespinal lamina of *Qaikshaheen masoomniazi* is narrower [54]. Its serial position is not found due to lack of coastal articulation, however the occurrence of postzygapophyses close to mid line indicates mid to posterior dorsal vertebra. Its preserved height is 14 cm and width is 12 cm. The anterior face of neural spine is concave bounded by left and right prespinal laminae. Further downward it joins with spinoprezygapophyseal lamina which is comparatively thin and narrow. The medial fossa at the junction of both laminae is transversely wide. The posterior face of neural spine is also concave bounded by left and right postspinal laminae. Prespinal and postspinal laminae ended before summit of neural spine. The neural arch is pneumatic having large and small camellae. Many cervical ribs and proximal, mid and distal parts of thoracic ribs are documented (**Figure 16**), while numerous pieces of thoracic ribs were collected but not documented so far. Cervical ribs are open V-shaped. Ventrally they are convex forming anteroposteriorly longitudinal ridge and dorsally they form open syncline type long valley. Tuberculum and capitulum of thoracic rib are of subequal size, subrounded capitulum and oval to suboval tuberculum and are marked with a notch in between. The proximal and mid part of the rib is spongy and concavo-convex in cross section. The distal rib is non-spongy.

Caudals found positioned in anterior (known by well developed transverse process; (**Figure 16**), mid and posterior series. Its first caudal is biconvex like those of *Marisaurus jeffi* from Pakistan, South Asia, *Alamosaurus* from USA, North America [102] and *Neuquensaurus australis* and *Pellegrinisaurus powelli* from Argentina, South America [103]. Its biconvex first caudal is more broad than *Marisaurus jeffi* first biconvex caudal. Its caudals are short like *Qaikshaheen masoomniazi*, while *Nicksaurus razashahi* has extremely short. Its mid caudals are squarish and strongly reduced in ventral views like *Qaikshaheen masoomniazi* caudals, while *Gspsaurus pakistani*, *Nicksaurus razashahi*, *Imrankhanshaheen masoombushrai* have somewhat reduced; *Pakisaurus balochistani*, *Khanazeem saraikistani*, *Imrankhanhero zilefatmi*, *Isisaurus colberti* and *Sulaimanisaurus gingerichi* have no significant ventral reduction while in opposite *Khetranisaurus barkhani* has more ventral width than dorsal width. Its lateral side is more concave like *Qaikshaheen masoomniazi* while *Nicksaurus razashahi* has slightly concave lateral sides. Its posterior caudals are cylindrical. Its distal caudal neural arch has trirays; including 2 prezygapophyses process and one ray for neural spine and postzygapophyses. Its caudal chevron is anteroposteriorly compressed like *Nicksaurus razashahi*, while *Khanazeem saraikistani* is transversely compressed.

Sternal plate: A part of anterior sternal is preserved. It consists of vertically oriented rugosities. Its upper and lower margin forms longitudinal ridges which are sandwiched by a valley type long depression (**Figure 17**). Its rugosities are prominent (**Figure 17**) than *Pakisaurus balochistani* sternal rugosities (**Figure 19**).

Humerus: Its proximal humerus has well developed head slightly migrated downward, it may be due to any stress (**Figure 17**). Its deltopectoral crest is destroyed. It has posterior plain surface just below the head like *Qaikshaheen masoomniazi*, *Imrankhanhero zilefatmi*, *Ikqaumishan smqureshi*, while *Pakisaurus balochistani* has dorsoventrally longitudinal ridge just below the head. *Balochisaurus* has expanded radial condyle anteriorly (**Figure 17**) while its shape and position is different than any other titanosaurs from Indo-Pakistan. *Balochisaurus malkani* has relatively large radial condyle positioned just close to lateral small condyle (**Figure 17**), while *Pakisaurus* radial condyle is positioned almost in the centre of distal transversal profile (**Figure 19**) and *Qaikshaheen masoom-*

niazi has relatively small radial condyle which is positioned just close to lateral small condyle (Figure 11 of [54]). Its distal humerus condyles strongly differ in proportions, while *Qaikshaheen* and *Pakisaurus* have subequal proportions, and *Imrankhanhero* and *Isisaurus colberti* [101] lack prominent distal radial condyles. Its olecranon fossa is narrower than that of *Pakisaurus*.

Ulna: Its trirays ulna is gracile (**Figure 17**). The proximal ulna is rugose and bears a prominent olecranon process. The proximal ulna represents a triradiate structure. There is a marked concave depression on the proximal lateral side. It has also depression on the medial side also. The posterior side have slight depression and almost smooth. Most of ulnae found from Indo-Pakistan are slender and have prominent olecranon process and have long trirays. The lateral ray is slender and has depression on dorsal view. *Balochisaurus malkani* has sharp blady edge (on lateral view) of slender lateral ray, while *Imrankhanshaheen masoombushrai* and *Pakisaurus balochistani* have lateral ray with rounded edge. Its long ray maximum width is about 5 - 6 cm like others found in Pakistan.

Metacarpal: Its metacarpals have expanded rugose ends (**Figure 17**). Its metacarpal end is strongly expanded like *Imrankhanshaheen masoombushrai*, while *Qaikshaheen masoomniazi* has moderate expanded end and *Imrankhanhero zilefatmi* has slightly expanded metacarpal end.

Acetabulum: The acetabulum is arc shaped with well developed glenoid (**Figure 17**). *Balochisaurus malkani* lacks or have feeble long fibrous structures like *Pakisaurus balochistani*, while *Imrankhanshaheen masoombushrai* acetabulum glenoid surface has prominent subparallel anteroposteriorly elongated fibrous structure. Its acetabular pubic peduncle is thick and triangular shaped while ischial peduncle seems to be relatively thin and platy like those of *Imrankhanshaheen masoombushrai*. *Balochisaurus malkani* acetabular pubic peduncle is triangular (about 70˚ and 30˚ angles from both end of base), while *Imrankhanshaheen masoombushrai* acetabular pubic peduncle is triangular shaped (about 45˚ angles from both end of base), *Pakisaurus balochistani* acetabular pubic peduncle is long oval shaped and *Isisaurus colberti* has subtriangular (about 20˚ angles from both end at base) [101].

Femur: Its femur (**Figure 17**) is robust like *Nicksaurus razashahi*, while *Marisaurus jeffi* has more robust femur, *Qaikshaheen masoomniazi* and *Gspsaurus pakistani* have slender femur, and *Pakisaurus balochistani*, *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* have more slender femur. Its greater trochanter is inclined, while *Nicksaurus razashahi* has greater trochanter which is relatively close to horizontal. Its femur is relatively moderate in size, while *Nicksaurus razashahi*, *Qaikshaheen masoomniazi*, *Imrankhanhero zilefatmi* and *Khanazeem saraikistani* has small femora, *Pakisaurus* and *Gspsaurus* has large femora, *Marisaurus jeffi* has more large femur. Its distal femur has lateral autapomorphic concavity on lateral profile just above the lateral condyle, while *Khanazeem* has lateral autapomorphic concavity just below the greater trochanter.

Tibia: The *Balochisaurus malkani* has more robust tibia with subequal transverse and anteroposterior width showing strong transverse expansion like those of *Qaikshaheen masoomniazi* from Pakistan, mid Cretaceous *Diamantinasaurus matildae* from Australia [122] [123], late Jurassic *Lusotitan atalaiensis* from Portugal [124], Late Cretaceous *Lohuecotitan pandafilandi* from Spain [125] and *Janenschia robusta* from the late Jurassic of Tanzania (Africa) [126], while *Gspsaurus pakist*ani and *Imrankhanshaheen masoombushrai* proximal tibia is robust and moderately transversely expanded (the anteroposterior width is 1.3 times transverse width), *Khanazeem saraikistani* and *Imrankhanhero zilefatmi* from Pakistan and *Igai semkhu* [127] from the late Cretaceous of Egypt proximal tibiae have transversely compressed flat tibia with more than twice or thrice anteroposterior width than transverse width.

8) *Qaikshaheen masoomniazi* [54]

Its basic data are mentioned in (**Table 10**). Its diagnosis, comparisons and descriptions are mentioned in [54], while here some additions are made. Its two neural arches (GSP/MSM-123-2; GSP/MSM-792-2) from mid Bor and one from mid Sangiali (GSP-UM/Sangiali-1104) (**Figure 18**) of dorsal vertebrae were found (Figures 2-5 of [71]; Figure 12 of [54]). The neural arch GSP/MSM-123-2 is a complement of mid Bor neural arch GSP/MSM-792-2 or mid Sangiali neural arch GSP-UM/Sangiali-1104. Neural arch GSP/MSM-792-2 have neural spine and left and right postzygapophyses (**Figure 18**). Postzygapophysis length is also slightly less than twice of its width. Postzygapophyses are elongated oval shaped facing lateroventrally. Neural arch GSP-UM/Sangiali-1104 have neural spine and left postzygapophysis (**Figure 18**). Postzygapophysis length is also slightly less than twice of width. Neural arch of anterior-mid dorsal vertebra GSP/MSM-123-2 (Figures 2-5 of [71]; Figure 12 of [54]) includes partial postzygapophyses, prezygapophyses, Parapophyses and diapophysis, only basal portion of neural spine and portions on neural canal. Its many laminae on posterior view were also reported (page 192 of [71]). The centrodiapophyses lamina extends from the diapophyses downward and joins with the infrapostzygapophyseal lamina, which again extends from the postzygapophyses downward to the floor of the neural canal. The postzygapophseal lamina is directed backward to the postzygapophysis and the supradiapophseal lamina is directed upward to the spine. Many fossae are bounded by these laminae. Further a network of laminae is also found on anterior view of neural arch of anterior dorsal vertebra GSP/MSM-123-2 (**Figure 18**) which is being described here. A lamina found which connects the left and right prezygapophysis. A lamina extends lateroventrally from prezygapophysis which joins with another lamina which continues medioventrally to the sides of neural canal. A feeble lamina runs downward directly from prezygapophysis to the sides of neural canal. A lamina runs from prezygapophysis to laterodorsal direction, little ahead it bifurcated into two laminae. One continues laterodorsal direction to the diapophysis and another runs to the mediodorsal direction to the neural spine (Figure 12 of [54]). It has lateral arc shaped lamina started from dorsal part of centrum and continues upto parapophysis. These laminae of *Qaikshaheen masoomniazi* differs from the dorsal vertebrae of *Gspsaurus pakistani* and *Isisaurus colberti* [101]. Its comparison with neural arch of *Balochisaurus malkani* is as above. *Qaikshaheen* neural spine is distinctive in its squat profile [92]. Its left coracoid GSP-UM/Sangiali-1112 is also distinctive revealing glenoid lacking lips, and having rounded inferior edge (see comparison with *Pakisaurus* as shown below). Its many pieces of thoracic ribs were collected from mid Sangiali (miscellaneous fossils in rows 3 & 4 of Figure 6 of [85]).

9) *Marisaurus jeffi* [68] vide [89]

Its basic data are provided in (**Table 10**). Its holotype was found in nearby two sites. The first site includes first biconvex caudal vertebra, scapula, pubis and femur which were found very close to each other. The other site consists of caudal vertebrae in about 10 m long linear assemblage (trending northeast to southwest direction) as surface finds toward southwest from first site. Both these sites may be about 10 - 20 m away (previously it was mentioned about 50 m ([89], page 421), it was only tentatively estimated and actually not measured). Caudal vertebrae GSP/MSM-15-15 (previously referred to *Pakisaurus* [70]), GSP/MSM-24-15, GSP/MSM-25-15 and GSP/MSM-26-15 (previously referred to *Sulaimanisaurus* [70]) found from Mari Bohri, may belong to vertebral series alignment of Mari Bohri type locality and in this way it may belong to type series of *Marisaurus jeffi*. I remember this series yielded much more than 5 vertebrae in an alignment, so I think these 4 vertebrae (**Figure 18**) may be found from this vertebral series. Further a dorsal vertebra GSP/MSM-134-8 and a caudal vertebra GSP/MSM-40-8 from Darwaza locality are being referred to it due to similarity of caudals. Its first biconvex caudal shows more broad transversely anterior articular condyle which show broad sacrals. Its posterior articular condyle is subcircular (**Figure 18**), which is differentiated from broad posterior condyle of *Balochisaurus malkani* (**Figure 16**). Its dorsal centrum is broad and pneumatic. Its first caudal transverse process are terminated above the mid height of centrum (**Figure 18**), while in *Balochisaurus* the transverse process extended downward (**Figure 16**). Its proximal scapula and femur are more robust, while other Pakistani titanosaur has robust and slender scapula and femora. Its pubis is robust with proximal and medioventral end expanded (**Figure 18**).

Pakisauridae [70] vide [88]

Represented by Pakisaurinae [76] (*Pakisaurus balochistani* and *Khanazeem saraikistani*), Isisaurinae [76] (*Imrankhanhero zilefatmi*, *Sulaimanisaurus gingerichi*,) and Khetranisaurinae [76] (*Khetranisaurus barkhani*).

10) *Pakisaurus balochistani* [68] vide [88]

Its holotypic and referred specimens (**Figure 19** & **Figure 20**) and basic data are mentioned in (**Table 11**). Its diagnostic features, comparisons and descriptions are as below.

Cranial material: A right parietal (with few teeth on its surface) GSP/MSM-353-4 (**Figure 20**) was collected from south Kinwa. It was found from the holotypic locality of *Pakisaurus balochistani*, which shows it is a part of holotypic individual. Its parietal faces consist of folded type uneven interdigitating midline sutures but generally the suture is straight. Anteriorly it is contacted with frontal. The parietal extends laterally to form a laterally tapering squamosal process. The distal end of squamosal process is eroded. Posterior view of parietal shows a concavity which inclided slightly anteriorly. The dorsoventral depth of concavity decreases to midline. While this depth is slightly decreased laterally upto preserved portions. This concavity is about 2 cm in the mid. The dorsal margin of concavity of posterior face is slightly rugose. Its parietal is anteroposteriorly expanded in the centre and reduced significantly laterraly like those of *Rapetosaurus krausei* [120]. Its anterior slope of posterior face occur in most titanosaurs (Rahioli braincase ISI R 162 [107], Dongergaon braincase ISI R 199 [106], *Jainosaurus* Bara Simla braincase GSI K27/497 [93], *Antarctosaurus wichmannionus* [110], *Nemegtosaurus* [111], *Quaesitosaurus* [116], *Malawisaurus* [105] and *Saltasaurus* [103]). Its elaongated lateral process is common in many titanosaurs except *Quaesitosaurus* [116]. It also shows supratemporat fenestra (**Figure 20**).

Vertebrae: Its cervical centra are broad, opisthocoelous and pneumatic. Its cervical centra relative size is moderate, while *Gspsaurus pakistani* have heavy mid cervicals. Its pleurocoel is elongated oval shaped. Its cervicodorsal is also broad and have short and broad pleurocoel. Its dorsal centra are also broad, opisthocoelous and pneumatic, and have shallow and relatively short pleurocoel. Caudals found positioned in anterior (known by well developed transverse process; (**Figure 19**), mid and posterior series. It's anterior caudal is broad and its neural arch extends downward upto mid dorsoventral width like *Marisaurus jeffi*, while *Balochisaurus* neural arch extends further downward. Its mid caudals are tall and have no significant ventral reduction. Its posterior caudal is tall, elongated and show a horizontal groove in the mid of posterior articular condyle (**Figure 19**). Its anterior caudal neural arch is vertical (**Figure 19**), while *Isisaurus colberti* caudal neural arch is directed posteriorly [101]. It has robust tall caudals, while *Khanazeem saraikistani* has more robust slightly tall caudal, and "*Titanosaurus indicus*" has more slender tall caudal. Its distalmost caudal centrum has median horizontal groove in posterior articular condyle (**Figure 20**). Its trirays distal caudal neural arch has anteriorly directed 2 prezygapophyses process and one ray for neural spine and postzygapophyses which are directed posteriorly.

Sternal: Its anterolateral and medial portions are preserved (**Figure 19**). Its media side is convexing medially. The anterolateral edge is maximum thick 6 cm with concave anterolateral border and has anteroventral crest and becoming gradually thin as proceeding posterior and medial directions. The anteroventral crest is diminishing as proceeding posteriorly. There are rugosities on the anterior, anterolateral, anteromedial of anterior of sternal plate. But the intensities of rugosities and thickness on anteroposterior edge of sternal plate of *Pakisaurus* *balochistani* are less (**Figure 19**) than the *Balochisaurus malkani* (**Figure 17**). The *Pakisaurus balochistani* sternal plate is relatively slender and 6 cm thick with feeble rugosities on the anterolateral edge while the sternal plate of the *Balochisaurus malkani* is relatively robust and stocky and 7 cm thick with strong dorsoventral rugosities on the anterolateral edge. These rugosities show connection with the scapular coracoid region and other fellow. The anteroventral crest is constricted dividing into lower and upper plates like structures. The upper and lower plates show cleavage like structures. Both plates have depressed line in between these plates. The plate is slightly concave on the ventral and dorsal sides. The anterolateral part is thick and sub rounded. From this thick corner the thickness is consistently reduced in the medial side. The anterior end is thickened by an obtuse ridge, which extends over the ventral side for about a decade centimeter. The medial side plate is convex and slightly expanded and rugose for the attachment of fellow. As a whole the medial plate is relatively thin as compared to anterolateral part.

Scapula: Its proximal scapula is slender (**Figure 19**), while *Imrankhanshaheen masoombushrai*, *Qaikshaheen masoomniazi* and *Gspsaurus pakistani* have robust proximal scapula, and *Marisaurus jeffi* has more robust proximal scapula. *Pakisaurus balochistani* has laterally directed (outwardly directed) proximal scapula with respect to mid scapula (**Figure 19**), while *Gspsaurus pakistani* and *Imrankhanhero zilefatmi* proximal scapulae are almost straight (lack outward deflection).

Coracoid: Its coracoid GSP/MSM-366-3 from Shalghara has glenoid lips and its inferior end form sharp and narrow pointed edge (**Figure 20**), while *Qaikshaheen masoomniazi* has smooth glenoid (without lips) and rounded inferior edge (Figures 11 & 13 of [54]). Its coracoid has same width (10 cm) as *Qaikshaheen masoomniazi* coracoid. Its coracoid has a deep gorge type depression found in between the glenoid and infraglenoid process (**Figure 20**), while this depression is relatively shallow in *Qaikshaheen masoomniazi* coracoid (page 1049; Figure 3 and pages 1049 of [90], its infraglenoid process seems to be extended away like *Qaikshaheen masoomniazi*.

Humerus: *Pakisaurus balochistani* has proximal humerus (**Figure 19** & **Figure 20**) with posterior mid ridge and triangular shape of shaft cross section just below the deltopectoral crest, and almost straight and medially inset deltopectoral crest like those of humerus of *Diamantinasaurus matildae* from Australia [122] [123] [128] and *Rapetosaurus krausei* from Madagascar [129], while *Gspsaurus pakistani* has almost straight and medially inset deltopectoral crest, and posteriorly plain surface just below the head and round shape of medial process, *Qaikshaheen masoomniazi* has sinusoidal and laterally inset deltopectoral crest, and posteriorly plain surface just below the head and quadrangular shaft cross section just below the deltopectoral crest, and *Imrankhanhero zilefatmi* and *Isisaurus colberti* have sinusoidal and medially inset deltopectoral crest and posteriorly plain surface just below the head and elliptical shaft cross section of shaft. *Pakisaurus* distal humerus has anteriorly expanded medial and lateral condyles and more expanded radial/median condyle, while *Balochisaurus* has anteriorly expanded medial condyle (ulnar condyle) and more dominantly expanded median condyle (radial condyle) shifted more laterally (than median condyle of *Pakisaurus*) and feebly expanded lateral condyle which mostly merged with the median condyle (radial condyle), and *Imrankhanhero zilefatmi* [54] and *Isisaurus colberti* [101] have distal humerus which have no anteriorly expanded any condyles (radial and ulnar condyles or lateral, medial and median condyles).

Radius: Its proximal radius (**Figure 20**) has feeble depression on dorsal view like those *Nicksaurus razashahi*, while *Gspsaurus pakistani* has relatively more prominent depression. Its proximal radius is more robust (like those of *Nicksaurus razashahi*) than *Gspsaurus pakistani*. Its proximal radius is oval shape with one pole thick and another pole relatively narrow. Its proximal radius is relatively less expanded like those of *Nicksaurus razashahi*, while *Gspsaurus pakistani* has more expanded proximal end of proximal radius. Its distal radius (**Figure 19**) is beveled medially like those of *Imrankhanshaheen masoombushrai*. It also has polygon shaped rugosities on the ventral view like *Imrankhanshaheen masoombushrai.*

Ulna: Its ulna (**Figure 19**) is trirays and has prominent olecranon process. Its lateral long process has less prominent depression than *Balochisaurus malkani*. Its comparison can be seen as above in *Balochisaurus malkani*.

Metacarpal: Its metacarpals (**Figure 19**) are robust, while *Balochisaurus malkani* have slender metacarpal. Its metacarpal have thick and expanded end, while *Balochisaurus malkani*, *Imrankhanshaheen masoombushrai* and *Qaikshaheen masoomniazi* has more expanded metacarpal ends.

Acetabulum: Its acetabulum (**Figure 20**) lacks or have feeble long fibrous structures like *Balochisaurus malkani*, while *Imrankhanshaheen masoombushrai* acetabulum glenoid surface has prominent subparallel anteroposteriorly elongated fibrous structure. *Pakisaurus balochistani* acetabular pubic peduncle is transversely oval shaped, while *Balochisaurus malkani* acetabular pubic peduncle is triangular (about 70˚ and 30˚ angle from base), *Imrankhanshaheen masoombushrai* acetabular pubic peduncle is triangular shaped (about 45˚ angles from both sides at base) and *Isisaurus colberti* has slightly curved subtriangular (about 20˚ angles from both sides at base) [101].

Femur: *Pakisaurus balochistani* femur head is inflected and obliquely oriented dorsally (**Figure 19**). *Pakisaurus balochistani* has more slender femur like those of *Khanazeem saraikistani*, while *Qaikshaheen masoomniazi* and *Gspsaurus pakistani* have slender femora, *Balochisaurus malkani* and *Nicksaurus razashahi* have robust femora, and *Marisaurus jeffi* has more robust femora. Its dorsally inflected head is its autapomorphy.

Fibula: Its proximal fibula (**Figure 19**) is large and anteroposteriorly more wide like those of *Imrankhanhero zilefatmi*, while *Gspsaurus pakistani* and *Ba-*

lochisaurus malkani have small and anteroposteriorly less wide fibula. Its proximal fibula has rugosities on proximal end which extends on medial and lateral sides, this feature is not found in *Imrankhanhero zilefatmi* and *Imrankhanshaheen masoombushrai* fibula.

Ungual: A pedal skinny ungual GSP/MSM-152-3 found is much deeper dorsoventrally than broad transversely (**Figure 20**) well shown in Figure 3 of [90]. Its anterior portion is thick and posterior portion forms thin and narrow rounded edge. It is interesting the bone is enveloped by a thin layer of osteodermal skin (Figure 3 of [90]) which is well described in (page 1065 of [90]).

11) *Khanazeem Saraikistani* [90]

Its holotypic materials (**Table 11**) consist of left and right femora, left and right humeri, right tibia, distal fibula, caudal vertebra and partial dentary ramus with articulated partial teeth (**Figure 21**) Its referred associated remains are a hind limb elements such as tibia, fibula and metacarpal (**Figure 21**). Its basic informations are shown in (**Table 11**). Its diagnosis and formal descriptions are shown in ([90], pages 1098-1105). Its distal humerus is being recognized as right proximal humerus, which also include mid humerus (**Figure 21**). The left proximal and mid humerus is also shown in (**Figure 21**). The proximal humerus with head is well preserved while its deltopectoral crest is destroyed. It has widely spaced teeth (relatively wide space between two teeth) like *Mansourasaurus shahinae* [100] from northern Egypt, Africa, which show Indo-Pakistan subcontinent paleobiogeographic link with Africa. Its caudal is more robust and slight tall. Its chevron is transversely compressed while *Ikqaumishan* and *Nicksaurus* have anteroposteriorly compressed. Its distinct femora are more slender and have more inflected head and concavity between the proximolateral corner of the femoral head and the lateral bulge (wavy style) [90]. Its slender and almost flat tibia is like those of *Imrankhanhero zilefatmi* (**Figure 22**) from Pakistan, and *Igai semkhu* [127] from the late Cretaceous of Egypt, while *Gspsaurus pakistani* and *Imrankhanshaheen masoombushrai* have robust proximal expanded tibia, and *Qaikshaheen masoomniazi* and *Balochisaurus malkani* have more robust proximal tibia. Its almost complete tibia is preserved (**Figure 21**). *Khanazeem* and *Imrankhanhero* distal tibiae are expanded anteroposteriorly, astragalar fossa is larger and located in the mid/centre between its long and short processes (**Figure 21**, **Figure 22**) and differ from those of *Gspsaurus*, *Ikqaumishan* and *Nicksaurus* distal tibiae which are expanded transversely, astragalar fossa is relatively small and located in front of its short process (**Figure 10**, **Figure 12**, **Figure 15**).

12) *Imrankhanhero zilefatmi* [54]

Its holotypic fossils are right humerus, right femur and right fibula (**Figure 22**) (Figure 10 of [54]). It was referred flattened tibia, fibula and metatarsal from Zubra peak due to sharing fibula shape similarity. South Zubra (located on just southern slope of Zubra peak) yielded caudal vertebrae GSP/MSM-523-7, GSP/MSM-524-7, right mid scapula GSP/MSM-746-7 and osteoderm ellipsoidal plate GSP/MSM-84-7 (**Figure 22**) which are being referred to it on the basis of close occurrence of Zubra peak tibia, fibula and metacarpal, it may belong to single individual. Further referred tibia K 20/321 (Figures 4a, b, of Plate 1 of [93]) and right fibula K 27/489 (Figures 5a, b, of Plate 1 of [93]) from Bara Simla, India were referred to *Imrankhanhero zilefatmi* due to shape resembling with its South Zubra exemplar's tibia and fibula. Its basic data are shown in (**Table 11**). Its some additive description is presented as below. Its anterior caudal vertebrae are broad. Its mid scapula shows no lateral or outward deflection of proximal humerus like *Gspsaurus pakistani* and probably *Qaikshaheen masoomniazi*, while *Pakisaurus balochistani* has laterally or outwardly deflected proximal scapula. *Imrankhanhero* and *Khanazeem* distal tibiae are expanded anteroposteriorly, astragalar fossa is larger and located in the mid/centre between its long and short processes (**Figure 21**, **Figure 22**) and differ from those of *Gspsaurus*, *Ikqaumishan* and *Nicksaurus* distal tibiae which are expanded transversely, astragalar fossa is relatively small and located in front of its short process (**Figure 10**, **Figure 12**, **Figure 15**). It has large osteodermal ellipsoid without median cut (**Figure 22**) which resemble with *Malawisaurus* [105] of Malawi, Africa (show paleobiogeographic link with Africa). While *Gspsaurus pakistani* (**Figure 11**) from Pakistan, South Asia and titanosaur (plate 77 of [103]) (Figure 4 of [104]) from Argentina, South America have large ellipsoidal plate but with median cut (show paleobiogeographic link with South America). Its further diagnosis and formal descriptions are shown in ([54], pages 1098-1105).

13) ***Sulaimanisaurus gingerichi*** [68] vide [88]

Its holotypic and referred specimens, type and referred localities, horizon and age along with year of informal and formal description and basinal distribution were mentioned in (**Table 11**). Its diagnosis and descriptions of caudals are also shown in ([70], pages 112-113). Its four caudals found positioned in anterior (known by well developed transverse process0, while other 3 belong to mid caudal series. Its caudal vertebrae are squarish with no ventral reduction like *Isisaurus colberti* [101].

14) ***Khetranisaurus barkhani*** [68] vide [88]

Its holotypic and referred specimens, type and referred localities, horizon and age along with year of informal and formal description and basinal distribution were mentioned in (**Table 11**). Its diagnosis are shown in ([88], pages 296-298). Its descriptions are shown in ([70], page 113). Transverse width of its caudal vertebrae is broad ventrally than dorsally, which makes unique in Indo-Pakistani titanosaurs.

3.3.2. Revision of Theropod Dinosaurs from Pakistan

From Pakistan only 3 theropod species were reported so far and from India about a dozen theropod species were reported, while in contrast from Pakistan about a dozen species of titanosaurian sauropods are documented.

Vitakrisauridae [9] vide [88]

Represented by *Vitakridrinda sulaimani*, *Vitakrisaurus saraiki* and *Shansaraiki insafi* theropods.

1) ***Vitakridrinda sulaimani*** [68] vide [88]

It was based on holotypic materials (**Figure 23**) consisting of more than 10 teeth, a pair of femora and a pair of dorsal vertebrae from central Alam 19 locality. Its referred materials include anterior dorsal vertebra from Sangiali, two tall dorsal vertebrae, a single distal tail vertebra and meta tarsal from Top Kinwa, one anterior caudal and one middle caudal vertebrae from Mari Bohri locality, a single anterior dorsal vertebra from Sangiali and a metatarsal from south Kinwa. Its basic data are shown in Table 5 of [17]. Its description of holotypic and referred fossils are shown in ([88], pages 302-303) and described in ([87], pages 512-520). Its distinguishing characters are well described by ([90], pages 1066-1067).

2) ***Vitakrisaurus saraiki*** [9] vide [88]

Its formal description year, holotypic specimens (**Figure 24**), type locality, horizon and age and basinal distribution were mentioned in Table 5 of [17]. Its holotypic materials include caudal vertebrae, humerus, ulna, manus and a few other limb bones (**Figure 24**) from mid Bor locality [88] and referred materials include a few limb bones (**Figure 24**) from Pakistan [88] and an amphicoelous vertebra with small sized chevron (**Figure 24**) from India [87] [88]. *Vitakrisaurus saraiki* have elongated and tall caudal vertebrae while *Vitakridrinda sulaimani* have elongated and square shaped to cylindrical caudal vertebrae. *Vitakrisaurus saraiki* neural canal is dorsoventrally compressed, transversely oval shaped in anterior caudal and also in middle caudal vertebrae while *Vitakridrinda sulaimani* neural canal is dorsoventrally tall suboval shaped in anterior caudal vertebrae. Its comparison and detailed description of above bones can be found in [87] [88].

3) ***Shansaraiki insafi*** [90]

Its holotypic specimens (**Figure 25**) and other basic data were mentioned in Table 5 of [17]. Its formal description of cranial and postcranial materials were described in ([90], pages 1067-1071). Some description was added by ([17], page 937) are as. Its dentary ramus (GSP-UM/MSM-5-3) has preserved 2 teeth and one alveolus. Its medial side has two large medial dental foramina (**Figure 25**). These foramina are alternated with teeth roots. Foramina are large and more than 1 cm in diameter. These foramina approach to roots of teeth and used for nerve and blood supply to dentary teeth, gums, muscles and tissues. Teeth are oval shaped and D-shaped asymmetrical (large size) to circular (medium sized). Large tooth have thick peripheral bone while small teeth show relatively thin peripheral bone while thickness vary in periphery. Further teeth cavity of small and large teeth is almost same size. The teeth outer surface is wrinkled i.e. teeth outer bone periphery show long pipe type or hair type fibrous texture. The contact of teeth peripheral bone with core cavity is uneven and rough ([17], page 937). Shansaraiki *insafi* characters and comparison is as below. *Shansaraiki insafi* dentary symphysis form V-shaped (**Figure 25**) which blunted as w-shaped anteriormost end, while *Rahiolisaurus* anterior jaw ramus shows curvature representing U-shaped anterior symphysis. The dentary ramus of *Shansaraiki insafi* does not bear lateral step, while *Rajasaurus narmadensis* represent lateral step on dentary ramus [130]. Dentary ramus is thick and deep and represents rough pitted structures and irregular lineations. *Shansaraiki insafi* has wide spaced between teeth on ramus while *Indosuchus* [93] have short, recurved and closely contacted teeth. The teeth of *Shansaraiki* and *Indosuchus* have different morphology on different positions. *Shansaraiki insafi* has oval and biconvex teeth (convexing on labial and also lingual sides) while *Vitakridrinda* has commonly D-shaped, oval and subcircular teeth. Its anteroposteriorly broad teeth matching with *Indosuchus* but differ on teeth shape. It has oval shaped teeth while *Vitakridrinda* has D-shaped, oval and subcircular teeth and *Rahiolisaurus* [131] has symmetrical cross sectional shape of teeth. Its teeth size and interdental spacing is almost same as *Rahiolisaurus* [131]. It has relatively rounded mesial keel and sharp distal keel on one tooth while *Rahiolisaurus* [131] has a faint mesial keel but rounded distal edge. It has symmetric and asymmetric both type of teeth, while *Rahiolisaurus* [131] has symmetrical oval teeth (*Rajasaurus* [131] has no preserved teeth for comparison). Its anteroposterior width of teeth is same as *Vitakridrinda* teeth [88] but relatively large than *Rahiolisaurus* teeth [131]. Its dorsal centrum is elongated cylindrical with circular shaped articular surfaces (**Figure 25**), while *Vitakridrinda* has tall and elongated dorsal centra (**Figure 23**), and *Rajasaurus* [132] has tall and short dorsal centrum. Its dorsal centrum is not spool-shaped, with its articular faces not deeper than broad while *Rajasaurus* [132] dorsal centrum is spool-shaped, with its articular faces deeper than broad. It has well developed amphicoelous concave articular surfaces (**Figure 25**) while the *Rajasaurus* [132] and *Rahiolisaurus* [131] have flat or gentle or faint amphicoelous nature.

Webbed foot of Marsupial (Mammalia) from Vitakri Formation of Pakistan

Systematic paleontology

Mammalia, Metatheria

Khansultan masoomrashidi new genus and new species (**Figure 17**)

Holotype: A partial webbed pes foot GSP/MSM-675-15 (**Figure 17**, row 4, p8, 9), housed in the museum of Geological Survey of Pakistan, Quetta.

Type locality, horizon and age: Holotype was found in Mari Bohri 15 (latitude 29˚41'57"N; longitude 69˚14'59"E) (Figure 4 of [88]), Barkhan district, Balochistan Province, Pakistan. Host horizon is the Vitakri Formation (**Figure 1**) of Fort Munro Group. Age of Vitakri Formation is latest Maastrichtian (see above).

Etymology: Genus name *Khansultan* honors Former Prime Minister of Pakistan Imran Khan, great journalists Imran Khan and Waqar Malik Khan and great leader Sanam Javaid Khan, and *sultan*, Saraiki for king. *Khansultan* can be pronunciated Khan Sultan. Species name *K. masoomrashidi* is after the *masoom*, Saraiki language for innocent, *rashidi*, to honor Dr. Yasmin Rashid Former Provincial Minister of Health of Punjab. Species name *K. masoomrashidi* pronunciated as masoom rashidi. All these supported poor peoples of Sulaiman Range (host of fossil).

Diagnosis and comparison: The presence of syndactyly in hind foot, its size and digits interpreted to belongs to Metatheria, Mammalia (possibly ancestor of Kangaroo related Marsupial). A syndactylous and planatar webbed partial hind foot GSP/MSM-675-15 (**Figure 17**, row 4, p8, 9) is sub rectangle shaped. Its anterior side is 10cm and posterior side is 8cm and lateral and medial sides are 8cm and 6cm and dorsoventral maximum thickness is about 1.5 cm. Its anterior side is relatively transversely broad and while posterior side is transversely narrows. Its bones seem to be enveloped by skin forming webbed planatar pes. Its surface represents shallow elongated ridges alternated by elongated shallow depressions. The elongated ridges represent the digit and depression line represents the contact of two digits. First digit is relatively thin, second and third digits are relatively thick, while fourth digit is more thick. It is possible the fourth digit may have fourth and fifth narrower digits. The length of preserved first digit is slightly short than fourth digit. In general the lengths of all preserved digits are subequal. Bones are exposed on preserved posterior end. The exposed bone of 3rd digit is slightly larger than 2nd digit. Both bones are broad transversely. This syndactylous hind foot shows rough iregular dendritic type rugose morphology on its skin surface. If this purely tentative interpretation is true, then *Khansultan* having larger size and syndactylous hind foot [133], may appear as a marsupial.

4. Conclusions

The discovery of many coal seams at depths in exploratory drill hole, sampling and chemical analyses of each bed of gypsum is a path finder for industrialist and planners to install cement and gypsum industries to export cement and gypsum product to increase foreign exchange for the development of area and Pakistan. Some chemical analyses and extension of sedimentary low to high grade iron stone and low grade silica sand deposits in Sulaiman and Kirthar foldbelt were also presented. Geochemical feeble anomalies are resulted after carrying geochemical exploration of part of Loralai District of Balochistan. More than 3 morphs of crania, 5 morphs of vertebrae especially caudal vertebrae, 3 morphs of scapulae, atleast 4 morphs of humeri, 3 morphs of coracoid, 3 morphs of acetabulum, 4 morphs of femora, atleast 3 morphs of tibiae and fibulae and more than 5 morphs of osteoderms of sauropods found from Pakistan. Although complete bones are rare, but the numerous bones (among the documented 400 bones) with numerous comparable and diagnostic features are common, which are the bases for more than a dozen species. *Saraikimasoom* is based on snout. *Gspsaurus*, *Imrankhanshaheen*, *Nicksaurus*, *Pakisaurus* and *Khanazeem* based on cranial, vertebral and appendicular elements. *Balochisaurus*, *Qaikshaheen, Marisaurus*, *Maojandino, Ikqaumishan* and *Imrankhanhero* based on vertebral and appendicular elements. *Sulaimanisaurus* and *Khetranisaurus* based on only caudal vertebrae. Most of these taxa have overlapped bone elements for comparisons with each other, and also abroad coeval taxa. 1 titanosauriform, 14 titanosaur and 3 theropod dinosaur taxa are documented so far. To know the position of these titanosaurs with global titanosaurs and sauropods needs broad character list for phylogenitic analyses which include the major characters of Pakistani titanosaurs and also from world.

Conflicts of Interest

Author declares no conflicts of interest regarding the publication of this paper.

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