INTRODUCTION

The famed Bugti Bone Beds of Baluchistan, western Pakistan, have inspired the imaginations of paleontologists for nearly 200 years. Bugti fossils, reputed to be abundant in the field, stimulated systematic studies on anthracotheres, rhinocerotids, and suoids, among other taxa. The spectacular, gigantic indricotheres (*Baluchitherium*) became well known from the material of Baluchistan. However, due to limited access and local politics of the region, it was not until late in the twentieth century that paleontologists returned to the Bugti area.

Raza and Meyer (1984) reported on brief reconnaissance in the Bugti area and tried to resolve several systematic problems. They evaluated the then known chronological data and concluded that an early Miocene age was reasonable for the assemblage. Although they suspected that fossils occurred throughout some stratigraphic thickness, the parsimonious view at the time was to consider the whole assemblage to be early Miocene in age. In 1978, I.U. Cheema (then with the Geological Survey of Pakistan [GSP]) collected sediment from Pazbogi Nala that produced a new group of rodents, the Baluchimyinae (Flynn et al. 1986), from the Bugti Beds of Baluchistan. Following Raza and Meyer, the Pazbogi Nala assemblage was considered early Miocene in age.

Later, extensive and well-organized fieldwork by French paleontologists and geologists (Welcomme et al. 1999, 2001) showed that fossils in the Bugti area span a long interval of time. The classic Bugti Bone Beds are concentrated low in the sequence, but many of the fossils, including proboscideans, occur stratigraphically higher. French colleagues suspected an Oligocene age for the Bugti rodents. Now faunal and stratigraphic data demonstrate conclusively that the Bugti Bone Beds significantly antedate earlier estimates, possibly dating to the early Oligocene in their interpretation. They found new site (Paali C2) with rich microfauna (Marivaux et al. 1999, Marivaux and Welcomme 2003) low in the sequence that was taxonomically similar to the material reported earlier from Pazbogi Nala.

While the French teams worked in the Bugti area, our group investigated sequences in the Zinda Pir Dome of the Sulaiman Range near Dera Ghazi Khan (Figure 1), where the Siwalik-like Vihowa, Litra, and Chaudhwan Formations overlie Bugti-like sediments of the Chitarwata Formation. The geology of the Zinda Pir Dome area was described by Hemphill and Kidwai (1973) in the context of a joint GSP-USGS mapping project. Our studies added paleomagnetic and biostratigraphic data for the Chitarwata and lower Vihowa Formations in the vicinity of Dalana, near the southern nose of the Zinda Pir Dome. We duplicated the Bugti microfauna low in the Chitarwata Formation in the Dalana region (Flynn and Cheema 1994), as well as adding microfauna and macrofauna of more modern aspect in higher levels of the Chitarwata Formation. We also collected fauna from the Vihowa Formation, resembling the basal Siwalik mammals recovered on the Potwar Plateau.

Together with Bugti, the Zinda Pir Dome sequence provides a more complete record of mid-Cenozoic evolution in southern Asia than was previously available. Our purpose is to report on the stratigraphy, sand-body analysis, fossils, and magnetic reversal stratigraphy of the Chitarwata-Vihowa sequence in the Dalana area. Interpretation of the paleomagnetic signal in the Dalana area has proven difficult. Problems involve stratigraphic hiatuses and weak, unreliable magnetic properties of some rock samples, low overall rate of sedimentation but locally highly variable sedimentation, and absence of datable volcanic deposits. However, although not conclusive in itself, the paleomagnetic information limits age estimates and supports greater antiquity for the base of the terrestrial sequence. We now conclude that deposition of the Chitarwata Formation in the Zinda Pir Dome area began during the Oligocene Epoch; however, resolution of the Oligocene chronology remains a problem.

Origin of the Zinda Pir Dome Initiative

Will Downs joined the Pakistan paleontological field crew during the 1980 field season and became the prime instigator of the small mammal project from 1989 until his untimely death in December 2002. The combined Yale University-GSP and Dartmouth-Peshawar University field parties had been working in Pakistan since 1973 to refine the biostratigraphic framework for the Potwar Plateau. Louis Jacobs initiated the small mammal fossil program in the 1970s, but rodent collecting thrived from 1980 until the last full-fledged field season in 2000 due to the energy and enthusiasm of Will Downs. Field programs in Pakistan declined thereafter, but Will continued doing field work with Steve Ward, Raza, Cheema, and Rajpar in the Zinda Pir area (Raza et al. 2002). Will Downs was the driving force for fieldwork in the Zinda Pir area since its beginning.

During the latter part of the 1980s, working primarily on the Potwar Plateau, our combined efforts yielded an impressive record (more than 18 my) of Siwalik paleontology and chronology (much of which is summarized in Badgley and Behrensm-

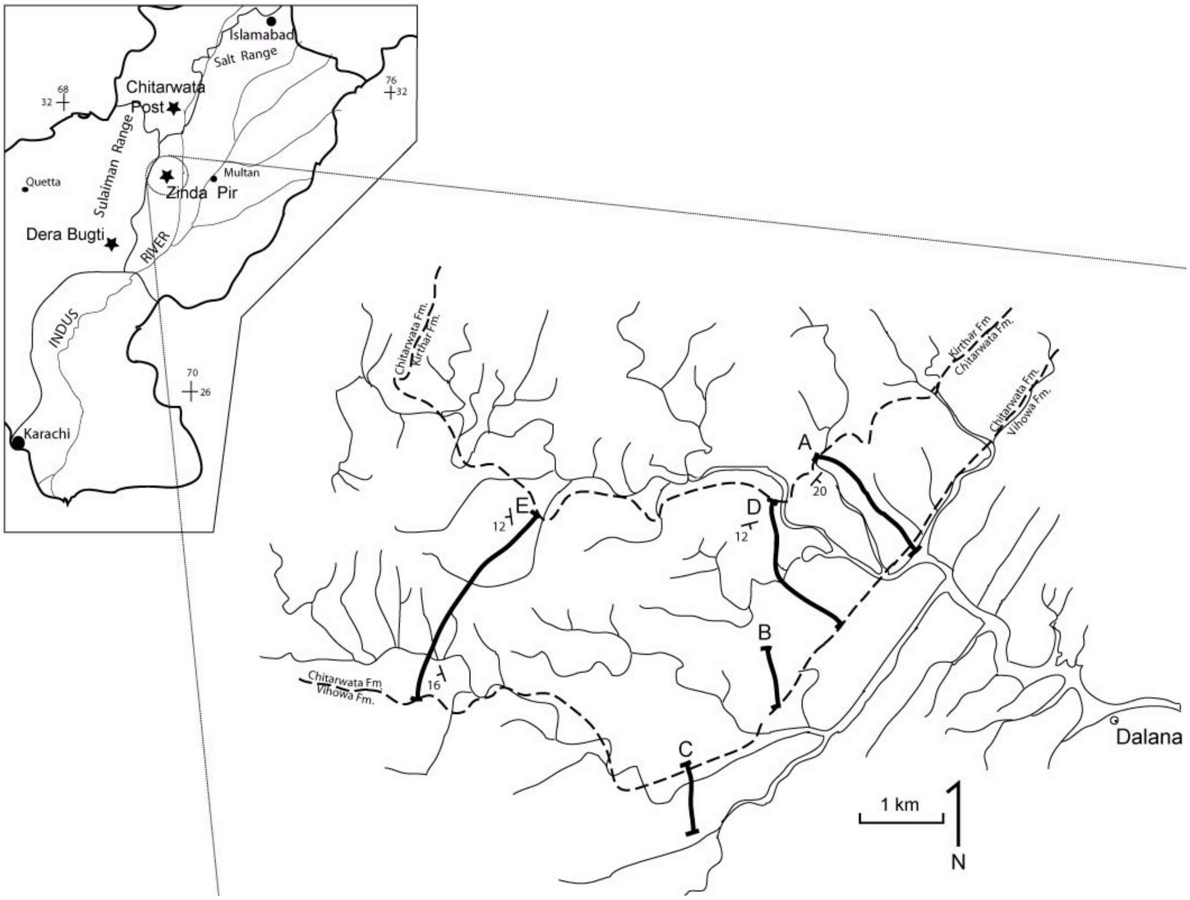

Figure 1. Map of the Dalana area in relation to Dera Bugti and Chitarwata Post. The five stratigraphic sections traversing the Chitarwata Formation and part of the Vihowa Formation are shown with letters. Scale is one kilometer.

eyer 1995). Thereafter, our attention turned to the major hiatus that underlies the Siwalik sequence on the Indo-Pakistan subcontinent. For years our travel to Pakistan included flights between Karachi in the south and Rawalpindi on the Potwar Plateau, where our Siwalik fieldwork took place. The route between Karachi and Rawalpindi traversed thick exposures of Siwalik-like strata along the forelands of the Sulaiman Range, west of Multan. Farther southwest of Multan, we knew that the Bugti Beds produced another impressive record of fossil mammals, and as our work on the Potwar Plateau reached maturity, our ambitions for doing fieldwork in the foothills of the Sulaiman Range grew.

The joint GSP-USGS project of Hemphill and Kidwai (1973) focused on the northern part of the Zinda Pir Dome. They recognized and named Siwalik-like sediments (Vihowa, Litra, and Chaudhwan Formations) in the Sulaiman Range and an older suite of terrestrial sediments they named the Chitarwata Formation. They believed the Chitarwata Formation was continuous with the Bugti Beds about 160 km south of the Zinda Pir Dome. Vertebrate fossils were virtually unknown from either the Siwalik-like beds or the underlying Chitarwata Formation in the Zinda Pir Dome until Raza and colleagues found evidence of fossils during an initial reconnaissance in 1988.

Study of the sedimentary sequence in the Dalana area began as a collaboration with the Pakistan Museum of Natural History (PMNH) in January 1989 when Downs, Lindsay, and Cheema flew from Islamabad to Multan and continued by bus to Dera Ghazi Khan (D.G. Khan), west of the Indus River. Four days were spent at D.G. Khan, making daily excursions by rental car (arranged by Cheema's cousin Nuveed Chaudhry) into the foothills of the Sulaiman Range to the west. About a ton of sediment from the Chitarwata and Vihowa Formations, collected near the village of Dalana, was hauled back to our base camp near Chinji on the Potwar Plateau, to process for small mammal fossils. Will, as principal collector, supervised screening of that preliminary sample of Zinda Pir sediment and transported the concentrate to the USA.

Will processed the screen-washed residue by heavy liquids at the Bilby Research Center, Northern Arizona University, during the following spring and summer. We were delighted to find that most of the rodents collected from the Chitarwata Formation were baluchimyines similar to those found by Cheema at Bugti. Preliminary analysis (Flynn and Cheema 1994) highlighted two new genera and four new species from the Dalana area.

A major effort was made in 1990 to collect more fossils from the Dalana area, place the fossils in a stratigraphic framework, sample the sediments for magnetic stratigraphy, and search for chronologic markers in those beds. Our results were published by Friedman et al. (1992) and Downing et al. (1993). Unfortunately, fieldwork was cut short in 1991 by the Gulf War and did not resume in the Dalana area until 2000, this time supported by the National Geographic Society. The results of that fieldwork and a summary of subsequent studies follow below. The most recent report of Zinda Pir paleontologic-geologic work (Raza et al. 2002) summarizes on-going investigations, especially those in younger sediments equivalent to the Siwaliks of the Potwar Plateau.

STRATIGRAPHY OF THE CHITARWATA AND VIHOWA FORMATIONS, ZINDA PIR DOME

Stratigraphic Sections

The Chitarwata and Vihowa Formations record a significant interval in the history of southern Asian vertebrate biodiversity, including the appearance of immigrant mammals from Africa and Asia, and poorly known chapters in the early history of both large and small mammals. Field seasons culminating in the year 2000 sought: 1) to gather paleomagnetic data from additional sections in the Chitarwata Formation; 2) to acquire sedimentary provenance and paleodrainage data; and 3) to collect fossils of under sampled groups. We recorded 60 fossil sites in the Chitarwata and Vihowa Formations, and amassed large samples of fossiliferous sediment from 10 sites, to process by screen washing for small mammals.

Our field area is indicated as Zinda Pir on Figure 1, with the village of Dalana shown above Dalana Nala, Dalana is west of the Indus River and on the eastern flank of the Sulaiman Range, near the southern end of the Zinda Pir Dome, in southern Punjab Province, approximately latitude N30º 5’, longitude E70º 20’. The type area of the Chitarwata Formation (Chitarwata Post on Figure 1), is about 120 km to the north of Dalana; type area of the Vihowa Formation occurs in the Zinda Pir Dome between Chitarwata Post and Dalana. The Bugti Beds are in the vicinity of Dera Bugti (Figure 1), south of the Zinda Pir Dome.

Hemphill and Kidwai (1973) named the Chitarwata Formation for exposures at Chitarwata Post. They measured its thickness near Domanda Post, 65 km north of Chitarwata Post, as 1260 ft (384 m) and noted that north of Domanda Post the formation thins rapidly, pinching out about 40 km north of there (Hemphill and Kidwai 1973). These authors did not measure the formation at the type area, but estimated its thickness there as only 500 feet (152 m), noting that the Chitarwata Formation is overlain by the Vihowa Formation in that area.

In 2000, we visited Chitarwata Post and measured total thickness of the Chitarwata Formation in its type area as 567 m (Figure 2). It appears that the 500-foot (152 m) thickness in the type section estimated by Hemphill and Kidwai (1973) is an underestimate and probably represents only the lower unit of the Chitarwata Formation that we recognize at Chitarwata Post and in the Dalana area. We collected no identifiable vertebrate fossils from the Chitarwata Formation along the stratigraphic transect in the type area, although proboscidean and rhino fossils were collected from the lower part of the Vihowa Formation in that area.

Our stratigraphic sections in the Dalana area are illustrated in Figure 3. The Chitarwata Formation is 413 m thick in section A, 397 m thick in section D, and 448 m thick in section E. We identified the contact of the Chitarwata with the overlying Vihowa Formation by a change from siltstones with discontinuous stringers of well-sorted sands to thick crossbedded and pebbly gray sands. In the Dalana area and at Chitarwata Post, we recognized three units in the Chitarwata Formation (Figure 3). In the Dalana area the lower unit represents estuarine facies and contains faunal elements of the classic Bugti Bone Beds; the middle sand unit yields fossil wood; and the upper unit is characterized by tidal flat to fluvial sand sheets and mudstones, and contains faunal elements resembling Siwalik early Miocene assemblages. The middle and upper portions of the Chitarwata Formation are not well developed north of the Chitarwata type area. Based on our work in the type area and at Dalana, it appears that the lower unit of the Chitarwata Formation thins to the south, from 323 m in the type area to 136 to 156 m in the southern end of the Zinda Pir Dome. In contrast, the upper member of the Chitarwata Formation thickens to the south; it is only 85 m in the type area and 192 to 236 m in the southern end of the Zinda Pir Dome. The three units in the Chitarwata Formation were not differentiated at Domanda Post or at Chitarwata Post by Hemphill and Kidwai (1973).

The base of the Chitarwata Formation is a distinctive transitional sequence between dominantly

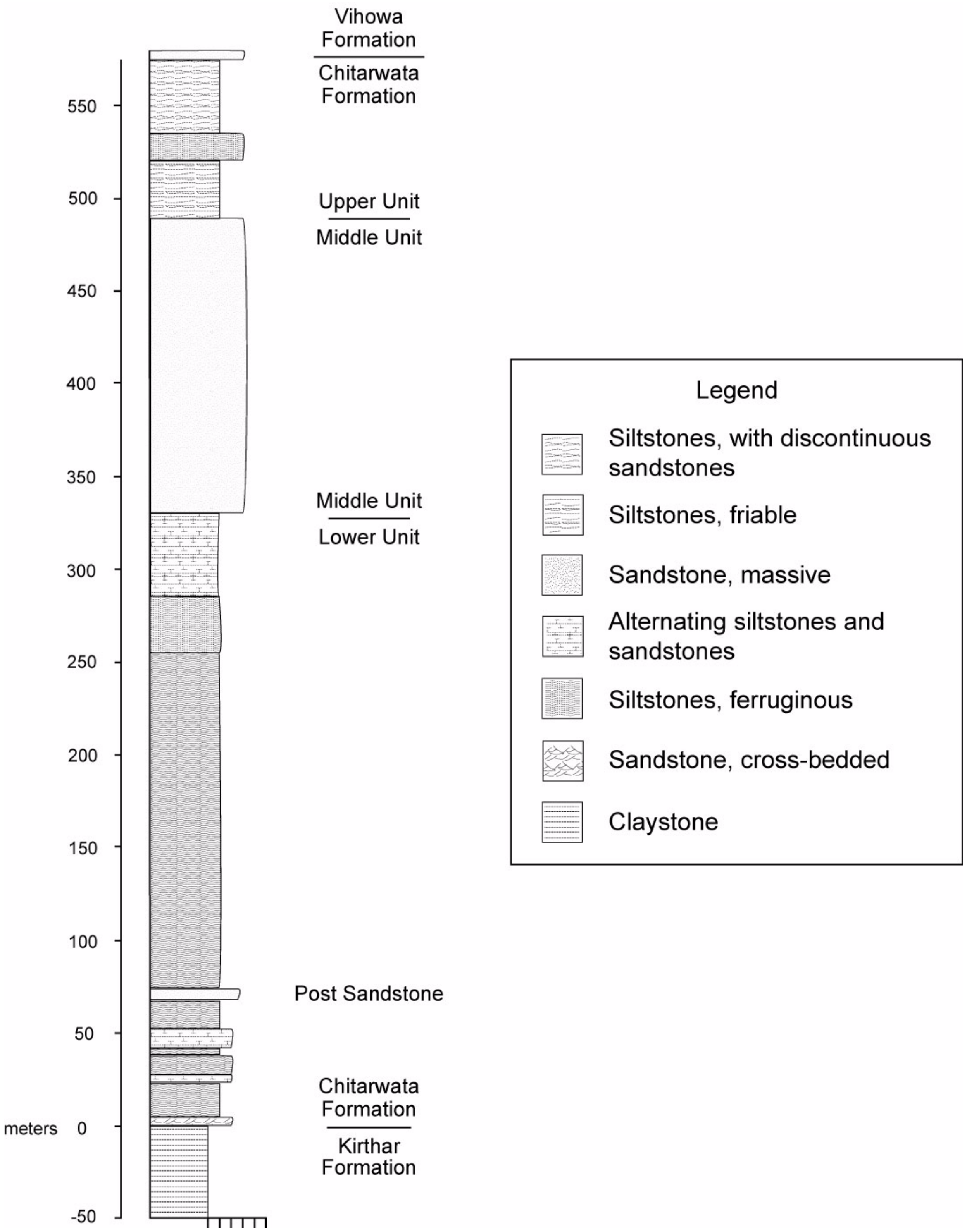

Figure 2. Measured section (in meters) of the Chitarwata Formation at Chitarwata Post.

fine-grained shales, siltstones, and sandstones yielding marine microfossils to overlying sandstones with prominent ferruginous *Thalassinoides* and *Skolithos* burrows. In the type area these burrows extend as high as 250 m above the base. Near the base, below Chitarwata Post, the near-vertical burrows are rounded, circular or oval in cross section, and average 16.9 mm in diameter (n = 11); distance between burrows varies from 20 to 100 mm (average 4.6, n = 14). In the type area ferruginous burrows frequently occur in the upper parts of friable siltstones, especially throughout the lower 100 m of the Chitarwata Formation. Ferruginous burrows, very prominent in the type area, are

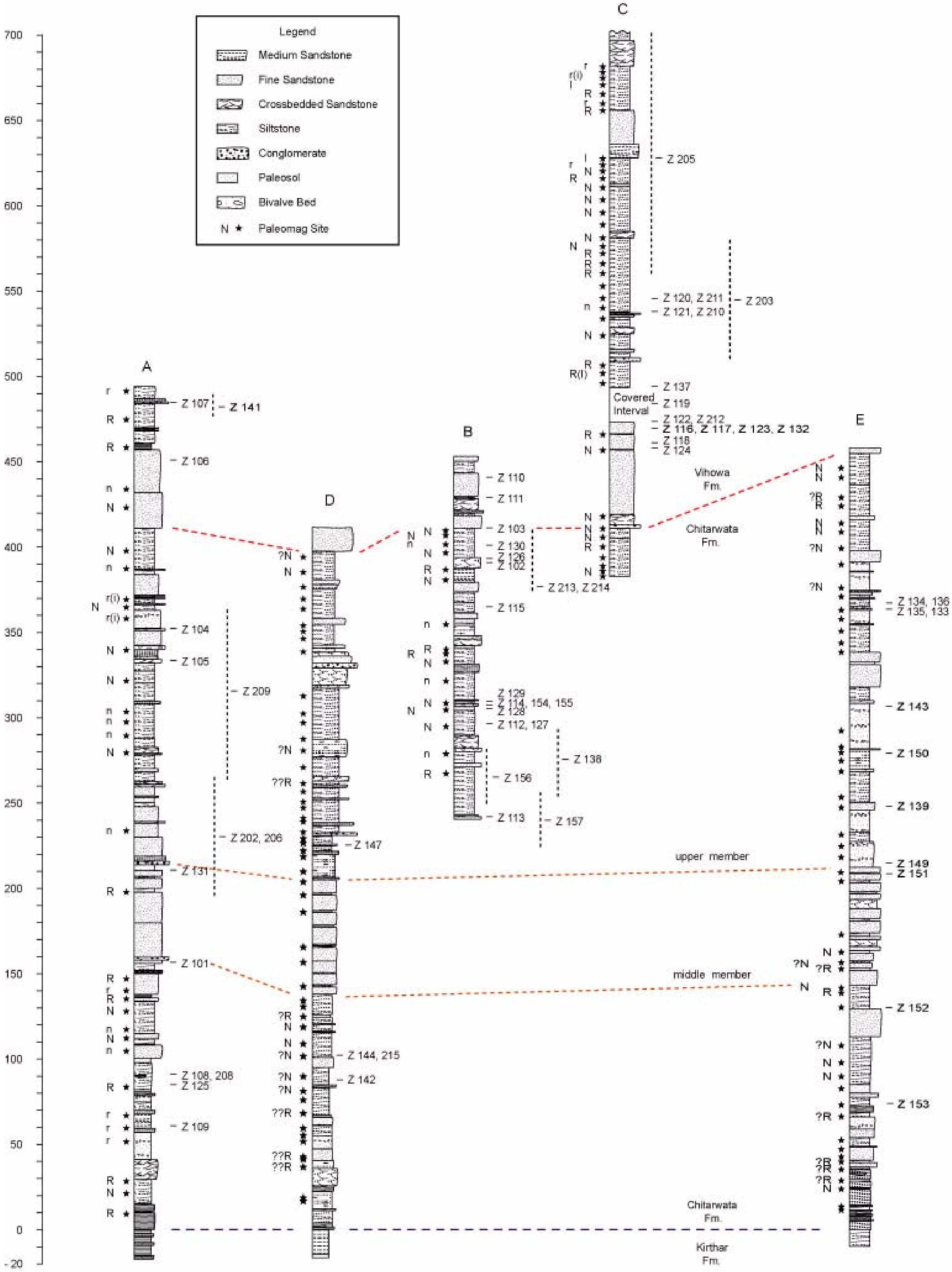

Figure 3. Stratigraphic data for the five sections of the Dalana area. In addition to lithology, paleomagnetic sites are indicated on the left of each section by a star. Well-resolved sites are indicated by N or R; less well resolved but still high quality sites, are lowercase n or r. On the right of each section, fossil localities (Z prefix) are plotted; vertical dashes indicate the range for those of less precise placement. Sections A-C were measured in 1989, sections D and E were measured in 2000. Stratigraphic thickness in meters.

less prominent at Dalana, extending only about 30-60 m above the base in that area.

These ichnofossils are characteristic of sandy shore and sandy backshore environments (Seilacher 1967) and indicate a change from marine to coastal environments of deposition. Hemphill and Kidwai (1973, p. B18) did not identify ichnofossils at the base of the Chitarwata Formation, but noted that "siltstone is variegated, friable, ferruginous; the sandstone is white, brownish yellow, subangular to subrounded, fine grained, friable, calcareous in places, and commonly ferruginous." They noted the contact of the Chitarwata Formation and the underlying Drazinda Shale Member of the Kirthar Formation is a persistent feature that can be recognized on aerial photographs along the foothills of the Sulaiman Range. Chitarwata Post is still prominently perched above the base of the lower member in the type area (Post Ss, Figure 2).

The upper unit of the Chitarwata Formation at Dalana is characterized by presence of sandstone sheets that often yield concentrations of marine pelecypods and gastropods. Ferruginous burrows, characteristic of the lower unit, are unknown in the upper unit; sandstone sheets with pelecypod-gastropod shell beds are unknown in the lower unit (Downing et al. 1993). The middle unit of the Chitarwata Formation is dominated by massive, well-sorted, yellowish-gray, medium to coarse sand with multi-storied tabular and trough crossbeds. Iron-rich concretions and abundant fragments of fossil wood are found on bedding planes throughout the unit, which is otherwise unfossiliferous.

The Chitarwata Formation, as we now understand it, represents deposition near the shoreline of the vestigial Tethys Seaway. The lower unit is thicker in the northern area of its distribution and the upper unit is thicker in the southern area of its distribution, probably as a function of different rates of sediment supply and accommodation to the north and south over time. It is reasonable to surmise that the units of the Chitarwata Formation had heterogeneous rates of sediment accumulation as is common in shallow marine settings under the direct influence of sea level change (Kidwell and Holland 2002).

The Dalana area, as a marginal marine environment in Chitarwata time, experienced marked changes in rate of sedimentation. The ichnofacies observed in the lower unit likely signify reactivation surfaces after hiatuses. The thin shell beds of the upper unit may reflect tens of thousands of years of accumulation in a sediment-starved setting. The overlying Vihowa Formation represents establishment of fluvial systems in this area, with rates of sediment accumulation more similar to those of Siwalik sediments of the Potwar Plateau.

Provenance of Sandstones and Paleodrainage

Detrital sediments shed into the late Cretaceous and early Tertiary Tethys Sea prior to and during collision of the Indo-Pak Continental Plate with the Asian Continental Plate are well known from northern Pakistan, primarily along the Himalayan-Hindu Kush collision zone (Garzanti et al. 1996). Garzanti et al. (1996) note dominance of feldspathic modes in sediments derived from the active Asian mainland, and quartzarenitic modes in sediment derived from the subducting Indo-Pak Plate. Pivnik and Wells (1996) show a shift along the western edge of the collision zone from reworked sedimentary rock in Eocene deposits, to metamorphic and igneous detrital modes in Miocene and later deposits.

In a preliminary provenance study of deposits in the Dalana area, Downing and Goebel (1991) identified a northern cratonic detrital mode for the Chitarwata Formation, and a recycled orogenic detrital mode for the Vihowa Formation. These early data show that the dominant detrital clast for the Chitarwata Formation is monocrystalline quartz; this mode is distinct relative to the Siwalik detrital mode, but indistinct relative to the underlying Eocene sediments. While these initial data signal the main shift of the Indus River drainage to the current Western Himalayan Foreland Basin, they do not tightly constrain provenance for sedimentary units within the Chitarwata Formation. A more detailed analysis of detrital provenance is warranted, particularly for sandstones in the pivotal upper unit of the Chitarwata Formation.

Paleocurrent analysis of trough and planar crossbedding in each of the members of the Chitarwata Formation by Downing and Lindsay (this issue) indicate a resultant mean drainage direction to the southeast. This is in general agreement with previous studies of the Chitarwata Formation (Waheed and Wells 1990), and with the southeast paleodrainage trend from the early Eocene through the Miocene in the Himalayan Foreland Basin. Paleodrainage and preliminary provenance data indicate that deposition of the Chitarwata Formation was separate from the Indus River drainage system to the east (Clift et al. 2001; Qayyum et al. 2001). The primary sediment source for the Chitarwata Formation was a regional highland to the northwest until the Indus River shifted to its current configuration in the western Himalayan Foreland Basin. The Chitarwata Formation represents a relatively stable coastline on the northern and western edge of the receding Tethys Sea during much of the Oligocene and early Miocene.

Magnetostratigraphy

Fieldwork and Previous Interpretation. Paleomagnetic samples were taken along five transects through the 700 m thick Chitarwata Formation and lower Vihowa Formation section near Dalana village (Figure 3). In 1989, samples from 125 sites in the Chitarwata and Vihowa Formations were processed at the paleomagnetic laboratory of Scripps Institution of Oceanography at UC San Diego (Friedman et al. 1992). Only 78 of those sites yielded polarity directions, of which 47 were from the Chitarwata Formation. In 2000, samples were collected from 100 sites in the Chitarwata Formation and processed at the paleomagnetic laboratory of the University of Arizona. Only 34 of those sites yielded polarity directions. During both periods of sampling we selected sites with uniform, fine-grained lithology judged most likely to produce stable polarity directions. Magnetic site positions are illustrated (as a star) in Figure 3 with polarities, where determined. These sections, arrayed from east to west (Figure 1), are relatively well exposed, and many of the lithologies can be recognized between transects and used for correlation between sections.

Our composite magnetic sequence (Figure 4) shows polarity data for the individual sections used to assemble it. In contrast to the Potwar Plateau where individual stratigraphic sections containing six or seven magnetozones are readily correlated (Johnson and McGee 1983) to the Geomagnetic Polarity Time Scale (GPTS), correlation of the Zinda Pir sections with the GPTS is much more difficult. Most of the 81 sites from the Chitarwata Formation that yielded stable polarity directions were from either the upper third or the lower third of the formation; the middle third was well sampled, but did not yield enough sites with stable data to correlate with confidence. Therefore, an interval approaching 100 m in the middle of the Chitarwata Formation is considered magnetically indeterminate, indicated as gray shading in Figure 4. We believe this enigma (weak and unstable magnetic properties) probably results from unresolved chemical or diagenetic attributes of these sediments. We are at a loss to explain why it occurs in approximately the same interval of three sections of the Chitarwata Formation, and why it is absent (or less pronounced) above and below that interval.

The magnetic sequence (Figure 4) has 13 reversed and 12 normal magnetozones numbered from top down, beginning with R1 and ending with R13. Magnetozone N4 is divided into upper and lower parts (N4U, N4L) at the formation boundary where we suspect a hiatus occurs; we offset the upper and lower parts of the composite to emphasize the suspected hiatus. Thickness of magnetozones R9 and N9, adjacent to the indeterminate interval, are unknown.

Friedman et al. (1992) evaluated four possible correlations of the Dalana magnetic sequence to the GPTS of Harland et al. (1989) using the three sections available then. Their favored correlation (option 4) included the interval between Chrons 5Br and 6AAr, which is reproduced in Figure 5, updated with new magnetic data in the GPTS of Cande and Kent (1995). Friedman et al. (1992) matched magnetozone N2 to Chron 5Cn, magnetozone N3 to Chron 5Dn, magnetozone N4-7 to Chron 5En, magnetozone N8 to Chron 6n, the indeterminate interval to Chron 6A.1n, magnetozone N11 to Chron 6A.2n, and magnetozone N12 to Chron 6AAn (Figure 5). Following the above correlation, fossil localities in magnetozone N3 (Vihowa Formation) would be slightly younger than 17.5 Ma, the Vihowa-Chitarwata contact would be about 18.5 Ma, and the Chitarwata localities of magnetozone N11 would be about 21.3 Ma, all securely in the Miocene Epoch. This correlation seemed reasonable for a relatively short section of 700 m.

In the fluvial deposits of the Siwalik Group on the Potwar Plateau, magnetozones as short as 50,000 years have been detected in adjacent sections (Tauxe and Opdyke 1982, Johnson et al. 1985), suggesting 1) sediment accumulation rates both rapidly and constant enough to capture short-lived events; and 2) absence of hiatuses of significant duration. These expectations were applied by Friedman et al. (1992) in their interpretation of the Dalana magnetic sequence.

The age estimates of Friedman et al. (1992) and Lindsay & Downs (2000) suggested that the Vihowa fossil localities were comparable in age to localities from the base of the Kamlial Formation in the Siwalik sequence (Johnson et al. 1985). This led to two other important conclusions: 1) There was a relatively continuous sequence of sediments and fossils from the base of the Chitarwata Formation up through the Vihowa Formation in the Sulaiman Range, comparable to the Kamlial and younger Siwalik Formations in the Potwar Plateau. 2) Similarities between fossils of the older Chitarwata levels and fossils from Dera Bugti supported the long held belief that the Bugti Beds were early Miocene (Pilgrim 1912) and subjacent to the continuous Siwalik sequence.

Recently, however, collecting and systematic work in the Dera Bugti area by members of the

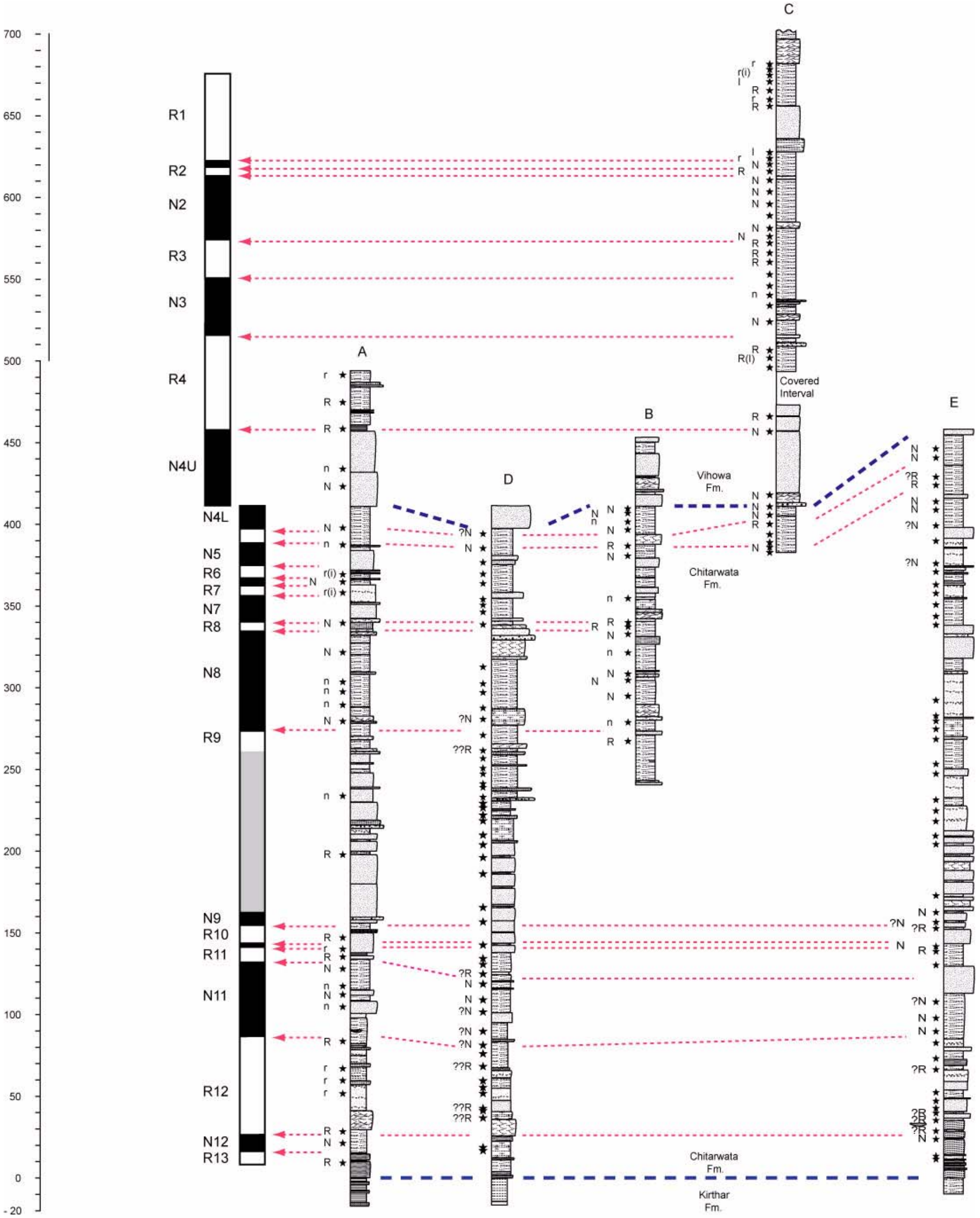

Figure 4. Composite magnetostratigraphy for the Dalana area. Correlations for the five stratigraphic sections are shown, and the resultant magnetozones are numbered R1, N1, R2, N2… R13 from the top.

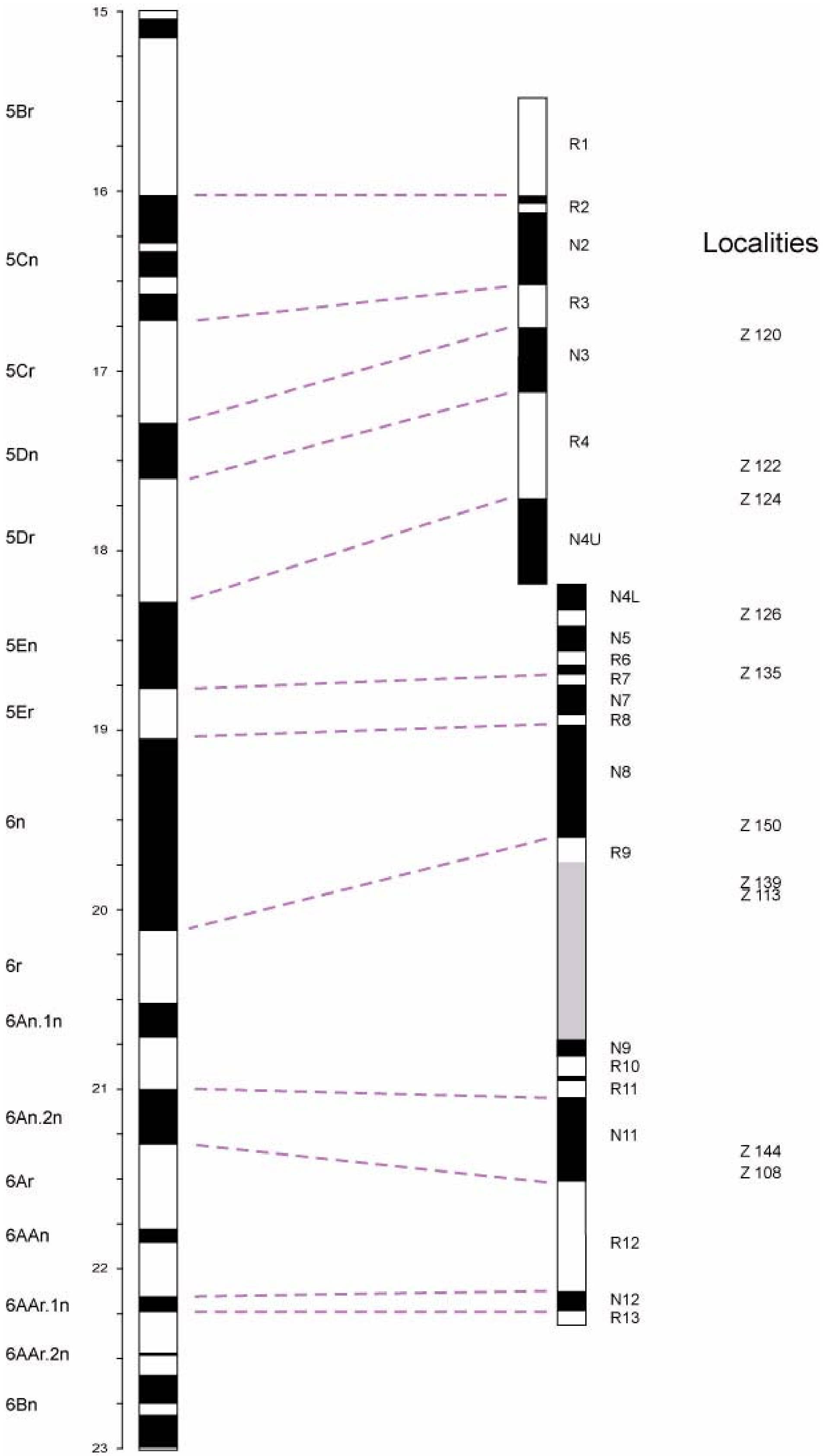

Figure 5. Preferred correlation of the Dalana magnetostratigraphy to the GPTS by Friedman et al. (1992) on the left, new composite magnetostratography (from Figure 4) on the right. Sequence of small mammal localities on the far right.

Mission Paléontologique Française au Balochistan has placed these correlations and conclusions in doubt (Welcomme et al. 1999, 2001). The reasons for proposing a significantly older age for the classic Bugti Beds are based on fauna. Many of the large mammals from the base of the Bugti section suggest, or are consistent with, an Oligocene age, but do not precisely identify how old the oldest assemblages might be. Small mammal taxa, especially the rodents *Atavocricetodon paaliense* and *Pseudocricetodon nawabi* from the bottom of the Bugti sequence were used to argue for an early Oligocene age. Unfortunately, these are new species and therefore their age is not independently confirmed from other dated localities. Marivaux et al. (1999) consider they indicate an age approximating European MP23, or about 31 Ma. The lower unit of the Chitarwata Formation near Dalana contains a similar large mammal fauna (but no similar rodents) implying a similar age.

We are now convinced that earlier correlations of the Dalana magnetic sequence are incorrect, and that most of the Chitarwata Formation was deposited during the Oligocene epoch. We recognize two possible correlations (A and B) for the Chitarwata Formation to the GPTS, which can be supported on different grounds. Interpretation A is consistent with an early Oligocene age for the base of the Chitarwata Formation, interpretation B is consistent with a late Oligocene age. Both of these possible correlations imply significant gaps in the deposition of the Dalana stratigraphic sequence; the only clear stratigraphic hiatus in the sequence that we have observed is at the Vihowa-Chitarwata contact.

Microfossils indicate that the lower part of the Vihowa Formation is older than the oldest Siwalik strata on the Potwar Plateau. Fossil site Z120 from the Vihowa Formation occurs in magnetozone N3; it produced *Democricetodon* sp. X, *Democricetodon* sp. A, and two species of *Prokanisamys* that resemble species recorded in the lowest Kamlial Formation sites Y721 and Y747. The Kamlial sites, correlated with Chron 5Dr, lack *Democricetodon* sp. X, but have *Democricetodon* sp.A, *Democricetodon* sp. C and the advanced muroid *Potwarmus primitivus*. Therefore, we consider locality Z120 predates the Kamlial sites, and we correlate magnetozone N3 to Chron 5En. This makes the base of the Vihowa Formation older than the interpretation of Friedman et al. (1992). The underlying normal magnetozone N4U is correlated with the upper part of Chron 6n, so the base of the Vihowa Formation in the Dalana area is about 19.5 Ma, 1 million years older than deposition of the Kamlial Formation.

The magnetic sequence of the Chitarwata Formation bears little resemblance to the magnetic sequence of the GPTS prior to Chron 6n. We must infer profound changes in rates of sedimentation or significant and multiple hiatuses in order to match the observed Dalana magnetic sequence to the GPTS. Our strategy is to infer multiple hiatuses in the upper unit of the Chitarwata Formation.

Multiple Hiatus Hypothesis. The top of the Chitarwata Formation has normal polarity (N4L) in all five sections, underlain by a sequence of reversals with dominance of normal polarity (magnetozones N4L through N8). Further, during this interval (N4L through N8) no more than two short reversed magnetozones are recorded in any of our sections, but tying the sections together yields a composite with four reversed magnetozones (Figure 4). Note that magnetozone R5 of sections B, C, and E (Figure 4) is absent in sections A and D; magnetozones R6 and R7 are represented only in section A, and magnetozone R8 occurs only in section B. We suspect that hiatuses approaching the duration of a magnetozone probably occur in each section, and that many of the reversals (or magnetozones) are not recorded or are reduced in thickness in some or all of these sections.

A key feature seen only in the upper unit of the Chitarwata Formation is the presence of multiple, widespread shell beds within a dominantly terrestrial stratigraphic sequence. These shell beds probably reflect surges that could scour and disrupt underlying strata to produce the numerous short-lived hiatuses we infer. Multiple hiatuses would condense or delete magnetozones, possibly still reflecting a polarity similar to but thinner than the polarity of the GPTS in that same interval. Following this line of reasoning, magnetozone N8 might represent the union of Chrons 8n and 9n (Figure 6a). Note that we infer these multiple hiatuses for only the upper unit of the Chitarwata Formation where the shell beds occur.

Hiatus at the Vihowa-Chitarwata Contact. We infer a hiatus at the Vihowa-Chitarwata contact because the magnetic sequence of the GPTS prior to Chron 6n is dominantly reversed whereas the polarity in the upper part of the Chitarwata Formation is dominantly normal (Figure 4). Support for this inference comes from the uneven thickness of strata at the top of the Chitarwata Formation (Figure 3), and truncation of Chitarwata strata underlain by the basal Vihowa sands, as traced along strike of the contact.

Assuming a hiatus between formations, magnetozone N4L may represent either Chron 6Bn.1n, with a gap of about 3 million years, (Interpretation

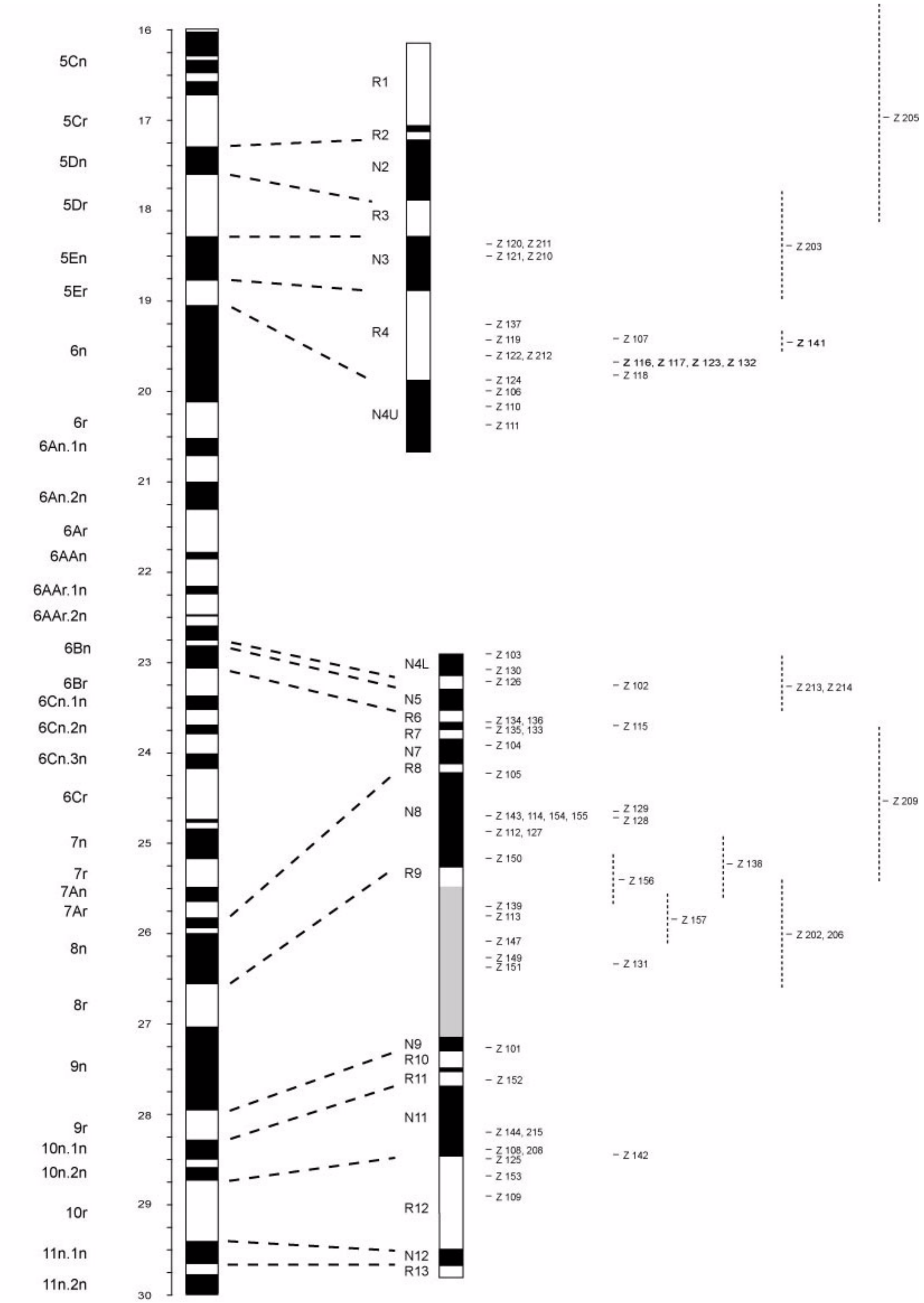

Figure 6. Two alternative correlations to the GPTS using the same new data. Figure 6A correlates magnetozone N4U with Chron 6n. It postulates a major hiatus above N4L and multiple minor hiatuses in the upper unit of the Chitarwata Formation; it correlates N11 with Chron 10n. Figure 6B has the same correlation for magnetozone N4U. It postulates a smaller hiatus above N4L and multiple minor hiatuses in the upper unit of the Chitarwata Formation; it correlates N11 with Chron 7n.

A) or the lower part of Chron 6n, with a gap of less than 1 million years (Interpretation B). Duration of Chron 6n is about 1 million years. Both interpretations infer multiple hiatuses of unknown duration during deposition of the upper member of the Chitarwata Formation.

Interpretation A (Figure 6A). Magnetozone N4U correlates with Chron 6n and N4L correlates with a normal chron of the GPTS prior to Chron 6r. Magnetozones R5-N7, with high frequency of reversals of short duration, is similar to the reversal sequence seen prior to Chron 6Ar and after Chron 6Cr (Figure 6A), suggesting that magnetozone N4L may represent part of Chron 6Bn. Younger chrons (e.g., Chron 6An.2n) are rejected because the interval between Chron 6r and 6Bn is dominantly reversed. Condensation of chrons between Chron 6Bn and 8n could produce the sequence of magnetozones R5 and R8.

The thick magnetozone N8, well represented in sections A and B, should correlate with Chron 8n or 9n, or as mentioned above, with both of these normal chrons. Chron 7n seems too short for correlation to magnetozone N8. If Chron 9n is not represented in N8 then magnetozone N9 is likely to represent the bottom of Chron 9n, and R9 might represent the upper part of Chron 8r with the indeterminate interval representing the rest of Chrons 8r and 9n (Figure 6a). There is another probable erosional break at the base of the middle unit of the Chitarwata Formation, which occurs in magnetozone R10.

A distinctive aspect of the lower part of the Dalana magnetostratigraphy is the long normal magnetozone N11 and subjacent longer magnetozone R12, underlain by a short magnetozone N12. Assuming a relatively uniform sedimentation rate, this reversal pattern rules out correlation of R12 with Chron 9r (whose superjacent normal chron is four times as long) or Chron 11r (whose subjacent Chron 12n is as long as Chron 11r). Chron 10r is the most likely correlate for magnetozone R12, because it assumes little change in sedimentation rate, equates magnetozone N9 with the base of Chron 9n, and correlates N12 with Chron 11n.1n (Figure 6a).

Correlation of magnetozone R12 to Chron 12r is not likely in our view because the overlying magnetozone N11 is too thick to represent Chron 12n. This would also require more hiatuses in the lower part of the Chitarwata Formation. We note the duration of Chron 12r is 2.1 my, but R12 represents a thickness of only 65 m. Therefore according to Interpretation A, base of the Chitarwata Formation near Dalana, equating magnetozone R13 with Chron 11n.1r, is about 29.6 Ma, early Oligocene.

Interpretation B (Figure 6B). This alternative view accepts the same interpretation for correlation of the Vihowa Formation and for multiple hiatuses in the upper unit of the Chitarwata Formation; it considers magnetozone N4L is the lower part of Chron 6n, inferring only a minor hiatus between the Vihowa and Chitarwata Formations. Resemblance of microfauna and large mammals from the upper part of the Chitarwata Formation and the lower part of the Vihowa Formation support an early Miocene correlation for N8.

Below magnetozone N4L (Figure 6b), the magnetic properties record many reversals but dominantly normal polarity (especially a long N8). The thick magnetozone N8 could correlate to either Chron 6Bn or Chron 8n. Chron 7n, which is bounded by relatively thick intervals of reversed polarity, is considered too thin for correlation to magnetozone N8, which is likely a condensation of several chrons. Correlation of magnetozone N8 with Chron 8n is rejected because it would require a greater time gap (more than 5.5 my) with no indication of a significant hiatus in the stratigraphic sequence. The base of the upper unit of the Chitarwata Formation is correlated therefore with Chron 6Bn, earliest Miocene.

The distinctive magnetic couplet of thick magnetozone N11 underlain by thicker R12 is replicated in sections A, D, and E; this couplet is overlain by followed by thin magnetozones R11, N10, and R10, and N9 with undefined thickness. Correlation of magnetozone N10 with Chron 7n.1n is rejected because the overlying magnetozone R10 is much too thin to correlate with Chron 6Cr. The distinctive couplet of magnetozones N11 and R12 seems best correlated with Chrons 7n-7r; correlation to Chrons 8n-8r is rejected because Chron 8r is thinner than 8n and R12 is thicker than N11. Similarly, Chron 9r is too thin relative to 9n for correlation with R12 and N11. Correlating magnetozone N11 with Chron 7n, would equate N12 with either Chron 7An or 8n.1n. If we correlate N12 with Chron 7An, the base of the Chitarwata Formation (magnetozone 13R) correlates with Chron 7Ar, about 25.7 Ma, late Oligocene. This interpretation projects sedimentation rates, except for hiatuses, on the order of 100 m/my.

Discussion. Interpretation A places the lower levels of the Chitarwata Formation in the early Oligocene. This interpretation requires a large hiatus at the base of the Vihowa Formation and projects other gaps within the upper unit of the Chitarwata Formation. Interpretation B places the lower levels of the Chitarwata Formation in the late Oligocene. This requires a small hiatus at the base of the

Vihowa Formation, as well as multiple gaps within the upper unit of the Chitarwata Formation.

When there are large or repeated gaps in the stratigraphic record the sedimentation rate is decreased, and the sedimentation rate depends more on hiatuses than on the actual rate of sediment accumulation. On the Potwar Plateau where fluvial Siwalik sedimentation is considered relatively constant, rates of sedimentation are highly variable, with maximum rates as high as 1000 m/my, and sometimes as low as 100-200 m/my. Slower rates of sediment accumulation are likely to miss more magnetozones.

We conclude that the base of the Vihowa Formation. (19.5 Ma or older) was deposited before the base of the Kamlial Formation in the Siwalik Group (18.3 Ma). The Vihowa Formation has been correlated with the Lower Siwaliks, and the base of the Siwalik sequence is generally considered a prograding wedge of sediments, younger farther from the Himalaya-Hindu Kush mountain ranges. The base of the Vihowa Formation, interpreted older than the Kamlial Formation and farther from the Himalaya front, puts the initial source and provenance of the Vihowa Formation into question.

Biostratigraphy

Small mammals. The stratigraphic sequence of screened microsites, from oldest to youngest, is Z108, Z144, Z113, Z139, Z150, Z135, Z126, Z124, Z122, and Z120 (Figure 5). Table 1 lists the fossil sites in the Dalana area with a comprehensive list of the vertebrate taxa identified from those sites. No vertebrate sites occur in the middle unit of the Chitarwata Formation. The last three sites listed above are in the Vihowa Formation.

Sites in the lower part of the Chitarwata Formation (e.g., Z108 and Z144) yield primitive baluchimyine and other rodents (*Asterattus*, *Baluchimys*, *Hodsahibia*, *Lindsaya*, *Lophibaluchia*, *Zindapiria*, *Downsimys*, and *Fallomus*). The Z108 fauna is not identical with, but resembles, the Bugti area Paali, C2 microfauna published by Marivaux et al. (1999) and Marivaux and Welcomme (2003). Locality Z108 records the Paali primate *Bugtilemur mathesoni*. However, we have not recovered the primitive muroids *Atavocricetodon* and *Pseudocricetodon* that Marivaux et al. (1999) found at Paali.

Table 1. Fossils (specimen counts) recovered from localities in the Dalana area. Identifications are to species level whenever possible. Localities are arranged in stratigraphic order, oldest on the left (specimen counts as oversized file). Also available is the specimen count and basic data file, tab delimited text; sheet SP_CNTS and basic data, tab delimited text. The following references describe some of the taxa listed in the table (Baskin, 1996; Flynn and Cheema, 1994; Lindsay and Downs, 1998). This is an oversize table and presented in at the end of this chapter.

Sites near the base of the upper part of the Chitarwata Formation (Z113 and Z139) yield *Primus*, *Spanocricetodon*, and *Eumyarion* (Lindsay and Downs 1998), along with a new genus more derived than *Fallomus,* the primitive ctenodactylid *Prosayimys*, a fossil bat, and a shrew. Higher levels (e.g., Z150) yield a more derived *Fallomus*, the first record of *Prokanisamys*, *Democricetodon*, *Primus, Spanocricetodon*, and three kinds of squirrel. The more advanced ctenodactylid rodent *Sayimys* along with *Prokanisamys*, *Primus,* and *Spanocricetodon*, and a squirrel are recorded from still higher in the upper unit (locality Z135, Figures 2 and 4). Our only small mammal site near the top of the Chitarwata Formation (locality Z126) yields two rodents, *Spanocricetodon* and *Prokanisamys*.

Many of these same rodents are recorded from the lower part of the Vihowa Formation (e.g., localities Z124 and Z122) along with *Megacricetodon* and *Myocricetodon*, plus a shrew, bats, a hedgehog, and the first record of *Diatomys*). The dominant rodents from the lower Vihowa Formation are *Democricetodon*, *Megacricetodon,* and *Myocricetodon*, along with the *Prokanisamys* and *Sayimys*. These rodents are also the dominant rodents in the lower part of the Siwalik Kamlial fauna on the Potwar Plateau. Similarity of rodents from the Vihowa and Chitarwata formations argue for absence of a major hiatus between formations in the Dalana area.

Fossils near the base of the upper unit of the Chitarwata Formation (localities Z113 and Z139) differ from fossils higher in the upper unit. Small mammals from the lower unit of the Chitarwata Formation are completely different from those in higher levels, implying significantly greater age, and therefore possibly major hiatuses.

In summary, small mammals demonstrate significant faunal turnover between the lower and upper units of the Chitarwata Formation; within the upper unit they indicate a faunal change of reduced magnitude above 250 m, and less change higher, at about 350 m. Welcomme et al. (1999, 2001) call for early Oligocene age of the lower part of the Bugti section, based on the Bugti fauna; and by inference, the basal Chitarwata section of the Dalana area.

A rich assemblage of rhinoceros species other than indricotheres and amynodontids is known from the upper unit of the Chitarwata Formation, and signals the appearance of lineages that continue into the younger Vihowa and Kamlial Formations.

Large Mammals. Large mammals also show important changes in the Zinda Pir Dome (Table 1). Dera Bugti produced large indricothere rhinos, which with the amynodontid *Cadurcotherium indicum*, dominate the lower part of the section. Their last records stratigraphically overlap the appearance of proboscideans (Antoine et al. 2003). Fossils as large as indricotheres should be readily found in the Dalana area, but to date our only confirmed indricothere material is from the lowest stratigraphic level (locality Z153) in the Chitarwata Formation. This is well below the appearance of proboscideans in the upper part of the Chitarwata Formation (locality Z154). Our lowest record of Proboscidea, in magnetozone N8, is chronologically provocative. Interpretation A places it in Chron 8n, making it older than 26 Ma, well down in the Oligocene. Interpretation B places the Proboscidea appearance in Chron 6Bn, slightly less than 23 Ma, in the early Miocene. The latter interpretation is in agreement with Antoine et al. (2003), who favor a late Oligocene age (24 Ma) for the Proboscidean occurrence in the Bugti Hills. The absence of indricotheres at locality Z154 may indicate that the Dalana proboscidean site is younger than the proboscidean record in the Bugti Hills (Antoine et al. 2004).

Anthracothere artiodactyls, particularly species of large body size, are characteristic of the Bugti fauna. Anthracotheres are found throughout most of the Chitarwata Formation, but species of smaller size are common in the middle of the upper unit (e.g., localities Z127 and Z129). The gigantic *Parabrachyodus hyopotamoides* persists up to at least the appearance of Proboscidea in the Dalana area but is documented from younger sites in the Bugti Hills (Welcomme et al. 2001). Primitive ruminants are also present throughout the Chitarwata Formation in the Dalana area but apparently become diverse only in the upper unit where taxa of more modern aspect appear. Tragulids occur at locality Z150 in the middle of the upper unit (Figures 3 and 5), while a more diverse assemblage of pecorans appears only slightly later. Bovids first appear in the Vihowa Formation, and this may be the oldest occurrence of the family anywhere.

Carnivorous mammals are rarely found and are represented mostly by larger taxa such as amphicyonids and creodonts. In the lower unit of the Chitarwata Formation a species close to *Alopecocyon* is known from a lower molar.

CONCLUSIONS

The Vihowa and Chitarwata Formations in the Dalana area of the Zinda Pir Dome record a significant interval in the history of mammalian evolution. We interpret the base of the Vihowa Formation in the southern end of the Zinda Pir Dome to occur in Chron 6n (about 19.5 Ma), at least a million years older than the base of the Siwalik sequence to the northeast in the Potwar Plateau. We measured the Chitarwata Formation in its type area, finding it significantly thicker then initially described, and characterized the basal part of the Chitarwata Formation as densely burrowed nearshore sands.

Upper levels of the Chitarwata Formation near Dalana are early Miocene in age; lower levels are Oligocene. Elements typical of the early Miocene Kamlial fauna of the Siwalik Group occur in early Miocene horizons of the Dalana area. Many of the lineages that occur in the upper part of the Chitarwata Formation also occur in the lower part of the overlying Vihowa Formation, suggesting that a minor hiatus separates these two bodies of rock. The upper unit of the Chitarwata Formation appears to encompass hiatuses, and this is reflected in faunal differences. Low in the upper unit, the appearance of proboscideans is dated as earliest Miocene (close to 23 Ma, in Chron 6Bn) or late Oligocene (Chron 8n), depending on correlation to the GPTS. Primitive species of early Miocene rodent lineages (sciurids, rhizomyids, cricetids, and ctenodactylids) appear near the base of the upper unit (localities Z113 and Z139) that is considered late Oligocene, about 27 or 23.5 Ma, depending on correlation to the GPTS.

The middle unit of the Chitarwata Formation has produced no terrestrial vertebrate fossils and represents strandline deposits; its paleomagnetic signal is too weak to interpret with confidence. The lower unit of the Chitarwata Formation is over 100 m thick, and therefore may span considerable time; it is Oligocene in age. This interval preserves baluchimyine rodents and indricothere rhinos. Small mammals from locality Z108 resemble those from Bugti localities Y417 and Paali, although Flynn and Cheema (1994) argued Z108 might be younger. Two alternative correlations to the GPTS place Z108 as early Oligocene, about 28.5 Ma, or late Oligocene, about 25 Ma. The former conclusion is consistent with the hypothesis of Marivaux et al. (1999) that the famous Bugti Bone Beds are early Oligocene.

ACKNOWLEDGMENTS

We acknowledge, of course, the creativity and enthusiasm of W. Downs, who made all of this work possible. We all shared many memorable field adventures with Will, and we all miss him. We also wish to thank the many citizens of the Dalana area who facilitated our research, and our colleagues at the GSP who freely shared information with us. We wish to thank the Pakistan Museum of Natural History for support, and National Geographic Society Grant 6402-99, as well as PL 480 funds administered through the Smithsonian Institution that enabled our fieldwork.

REFERENCES

Antoine, P.-O., Shah, S.M.I., Cheema, I.U., Crochet, J.-Y., de Franceschi, D., Marivaux, L., Metais, G., and Welcomme, J.-L., 2004. New remains of the baluchithere *Paraceratherium bugtiense* (Pilgrim 1910) from the late/latest Oligocene of the Bugti Hills, Balochistan, Pakistan. *Journal of Asian Earth Sciences*, 24:71-77.

Antoine, P.-O., Welcomme, J.-L., Marivaux, L., Ibrahim Baloch, Bennami, M., and Tassy, P. 2003. First record of Paleogene Elephantoidea (Mammalia, Proboscidea) from the Bugti Hills of Pakistan. *Journal of Vertebrate Paleontology*, 23:977-980.

Badgley, C. and Behrensmeyer, A.K. (eds.). 1995. Long records of continental ecosystems: Paleogene of Wyoming—Montana and Neogene of Pakistan. *Palaeogeography, Palaeoclimatology, Palaeoecology,* 115:1-340.

Baskin, J.A. 1996. Systematic revision of Ctenodactylidae (Mammalia, Rodentia) from the Miocene of Pakistan. *Palaeovertebrata*, Montpellier, 25 (1):1-49.

Cande, S.C. and Kent, D.V. 1995. Revised calibration of the geomagnetic polarity timescale for the late Cretaceous and Cenozoic. *Journal of Geophysical Research*, 97B:13917-13951.

Clift, P.D., Shimuzuz, N., Layne, G.D., and Blusztajn, J. 2001. Tracing patterns of erosion and drainage in the Paleogene Himalaya through ion probe Pb isotope analysis of detrital K-feldspars in the Indus Molasse, India. Earth and Planetary Science Letters 188:475-491.

Downing, K.F. and Goebel, K.A. 1991. Relationship of the India-Asia convergence to sandstone depositional environments and detrital modes in early Miocene deposits of Zinda Pir Dome, Pakistan. *Geological Society of America, Abstracts in Programs,* 23: A466.

Downing, K.F., Lindsay, E.H., Downs, W.R., and Speyer, S.E. 1993. Lithostratigraphy and vertebrate biostratigraphy of the early Miocene Himalayan Foreland Zinda Pir Dome, Pakistan. *Sedimentary Geology*, 87:25-37.

Downing, Kevin F. and Lindsay, Everett H. 2005. Relationship of Chitarwata Formation Paleodrainage and Paleoenvironments to Himalayan Tectonics and Indus River Paleogeography, *Palaeontologia Electronica,* Vol. 8, Issue 1; 20A:12p, 585KB; http://palaeo-electronica.org/paleo/2005_1/downing20/issue1_05.htm

Flynn, L.J. and Cheema, I.U. 1994. Baluchimyine rodents from the Zinda Pir Dome, western Pakistan: Systematic and Biochronologic implications, p. 115-129. In Tomida, Y., Li, C.K., and Setoguchi, T. (eds.), *Rodent Families of Asian Origins and Diversification*. National Science Museum Monographs, 8, Tokyo.

Flynn, L.J., Jacobs, L.L., and Cheema, I.U. 1986. Baluchimyinae, a new ctenodactyloid rodent subfamily from the Miocene of Baluchistan. *American Museum Novitates*, 2841:1-58.

Friedman, R., Gee, J., Tauxe, L., Downing, K., and Lindsay, E. 1992. The magnetostratigraphy of the Chitarwata and lower Vihowa formations of the Dera Ghazi Khan area, Pakistan. *Sedimentary Geology*, 81:253-268.

Garzanti, E., Critelli, S., and Ingersoll, R.V. 1996. Paleogeographic and paleotectonic evolution of the Himalayan Range, as reflected by detrital modes of Tertiary sandstones and modern sands (Indus transect, India and Pakistan). *Geological Society of America Bulletin*, 108:631-642.

Harland, W.B., Armstrong, R.L., Cox, A.V., Craig, L.E., Smith, A.G. and Smith, D.G. 1990. *A Geologic Time Scale 1989.* Cambridge Univ. Press, New York, NY, 236 pp.

Hemphill, W.R. and Kidwai, A.H. 1973. Stratigraphy of the Bannu and Dera Ismail Khan areas, Pakistan. *U.S. Geological Survery Professional Paper,* 716B:B1-B36.

Johnson, N.M. and McGee, V.E. 1983. Magnetic polarity stratigraphy: stochastic properties of data, sampling problems, and the evaluation of interpretations. *Journal of Geophysical Research*, 88(B2):1213-1221.

Johnson, N.M., Stix, J., Tauxe, L., Cerveny, P.F., and Tahirkheli, R.A.K. 1985. Paleomagnetic chronology, fluvial processes, and tectonic implications of the Siwalik deposits near Chinji Village, Pakistan. *Journal of Geology*, 93:27-40.

Kidwell, S.M and Holland, S.M 2002. Quality of the fossil record: implications for evolutionary biology. *Annual Review of Ecology & Systematics,* 33:561-588.

Marivaux, L. and Welcomme, J.-L. 2003. New diatomyid and baluchimyine rodents from the Oligocene of Pakistan (Bugti Hills, Balochistan): Systematic and paleobiogeographic implications. *Journal of Vertebrate Paleontology*, 23:420-434.

Marivaux, L., Vianey-Liaud, M., and Welcomme, J.-L. 1999. Première découverte de Cricetidae (Rodentia, Mammalia) Oligocènes dans le synclinal sud de Gandoï (Bugti Hills, Balochistan, Pakistan). *Comptes Rendus Académie des Sciences de la terre et des planètes*, 329:839-844.

Pilgrim, G.E. 1912. The vertebrate fauna of the Gaj Series in the Bugti Hills and the Punjab. *Geological Survey of India Memoirs, Palaeontologia Indica*, new series, IV(2):1-83.

Pivnik, D.A. and Wells, N.A. 1996. The transition from Tethys to the Himalaya as recorded in northwest Pakistan. *Geological Society of America Bulletin*, 108:1295-1313.

Qayyum, M., Niem, A.R., and Lawrence, R.D. 2001. Detrital modes and provenance of the Paleogene Khojak Formation in Pakistan: implications for early Himalayan orogeny and unroofing. *Geological Society of America Bulletin,* 113:320-332.

Raza, S.M., Cheema, I.U., Downs, W.R., Rajpar, A.R., and Ward, S.C. 2002. Miocene stratigraphy and mammal fauna from the Sulaiman Range, Southwestern Himalayas, Pakistan. *Palaeogeography, Palaeoclimatology, Palaeoecology,* 186:185-197.

Raza, S.M. and Meyer, G.E. 1984. Early Miocene geology and paleontology of the Bugti Hills, Pakistan. *Geological Survey of Pakistan Memoir,*11:43-63.

Seilacher, A., 1967. Bathymetry of trace fossils. *Marine Geology*, 5:413-428.

Tauxe, L. and Opdyke, N.D. 1982. A time framework based on magnetostratigraphy for the Siwalik sediments of the Khaur area, northern Pakistan. *Palaeogeography, Palaeoclimatology, Palaeoecology,* 37:43-61.

Waheed, A. and Wells, N.A., 1990. Changes in paleocurrents during the development of an obliquely convergent plate boundary (Sulaiman fold-belt, southwestern Himalayas, west-central Pakistan). *Sedimentary Geology*, 67:237-261.

Welcomme, J.-L., Bennami, M., Crochet, J.-Y., Marivaux, L., Métais, G., Antoine, P.-O.,and Baloch, I. 2001. Himalayan Forelands: paleontological evidence for Oligocene detrital deposits in the Bugti Hills (Balochistan, Pakistan). *Geological Magazine*, 138:397-405.

Welcomme, J.-L., Marivaux, L., Antoine, P.-O.,and Bennami, M. 1999. Mammifères fossiles des collines Bugti (Balochistan, Pakistan): Nouvelles données. *Bulletin Societé Histoire Naturelle, Toulouse*, 135:135-139.

GROUP_NAME		GENUS	SPECIES	Z109	Z153	Z125	Z142	Z208	Z108	Z144	Z105	Z104	Z152	Z101	Z151	Z131	Z149	Z206	Z202	Z147	Z157	Z113	Z139	Z156	Z150	Z127	Z112	Z128	Z143	Z155	Z154	Z114	Z129	Z209	Z133	Z135	Z136	Z134	Z214	Z213	Z102	Z126	Z103	Z111	Z110	Z106	Z124	Z118	Z132	Z117	Z116	Z212	Z122	Z141	Z107	Z119	Z137	Z210	Z121	Z203	Z211	Z120	Z205
Plantae		Indet. genus	indet. species	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ampullariidae		Pila	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
Malacostraca		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vertebrata		Indet. genus	indet. species	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Selachii		Indet. genus	indet. species	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Osteichthyes		Indet. genus	indet. species	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	1	0	0	1	1	0
Chelonia		Indet. genus	indet. species	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0
Testudinidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lacertilia		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
Varanidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Varanidae	cf	Varanus	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ophidea		Indet. genus	indet. species	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	6	0
Crocodilia		Indet. genus	indet. species	0	0	4	0	1	2	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0	5	0	8	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	1	0	1	0	0	2	1
Mammalia		Indet. genus	indet. species	0	0	0	0	1	18	5	0	0	0	1	0	0	0	0	0	0	0	3	4	0	1	3	1	2	0	0	0	0	2	0	0	1	4	0	0	0	0	1	0	0	0	0	2	1	0	0	0	0	8	0	0	0	6	0	3	0	0	2	0
Tupaiidae		Indet. genus	indet. species	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Erinaceidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0
Amphechini		Amphechinus	species B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Soricidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Chiroptera		Indet. genus	indet. species	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Strepsirrinii		Bugtilemur	mathesoni	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sivaladapinae		Guangxilemur	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Lorisidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rodentia		Indet. genus	indet. species	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rodentia, i.s.		Downsimys	margolisi	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rodentia, i.s.	?	Downsimys	margolisi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sciuridae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Petauristinae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cricetidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Eumyarioninae		Eumyarion	kowalskii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eumyarioninae	?	Eumyarion	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copemyinae		Democricetodon	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copemyinae		Democricetodon	species A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	48	0	0	0	0	0	0	0	0	12	0
Copemyinae		Democricetodon	species B	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0
Copemyinae		Democricetodon	species X	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	35	0	0	0	0	0	0	0	0	6	0
Copemyinae		Spanocricetodon	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	0	2	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copemyinae		Spanocricetodon	khani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	4	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copemyinae		Spanocricetodon	sulaiman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	5	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Copemyinae		Primus	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megacricetodontinae		Megacricetodon	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Megacricetodontinae	?	Megacricetodon	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	0	0	0	32	0
Myocricetodontinae		Myocricetodon	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myocricetodontinae		Myocricetodon	sivalensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	35	0	0	0	0	0	0	0	0	19	0
Myocricetodontinae		Myocricetodon	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myocricetodontinae		Myocricetodon	large species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Rhizomyidae, i.s.		Prokanisamys	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	36	0	0	0	0	0	0	0	0	1	0
Rhizomyidae, i.s.		Prokanisamys	arifi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0
Ctenodactylidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0
Ctenodactylidae		Sayimys	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Ctenodactylidae		Sayimys	cf. intermedius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	18	0
Ctenodactylidae		Z135 Sayimys	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ctenodactylidae		Prosayimys	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ctenodactylidae		Prosayimys	flynni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Indet. genus	indet. species	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Baluchimys	sp.	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Baluchimys	chaudryi	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Lindsaya	derabugtiensis	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Lophibaluchia	pilbeami	0	0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Hodsahibia	sp.	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Hodsahibia	kayi	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Asterattus	sp.	0	0	0	0	0	1	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Asterattus	longicristatus	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baluchimyinae		Zindapiria	quadricollis	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diatomyidae		Fallomus	sp.	0	0	0	0	0	132	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diatomyidae	cf	Fallomus	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diatomyidae		Diatomys	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Diatomyidae		Z113 "Diatomys"	n. sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Creodonta		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hyaenodontinae		Hyainailouros	sulzeri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Carnivora		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Amphicyonidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Procyonidae	cf	Alopecocyon	sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Proboscidea		Indet. genus	indet. species	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	0	1	0	0	1	0	0	3	0	0	3	2	0	1	0	0	1	0	0	0	0	0	0	0
Deinotheriidae		Deinotherium	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1
Elephantoidea		Indet. genus	indet. species	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Choerolophodon-group		Choerolophodon	corrugatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Amebelodontidae	cf	Protanancus	chinjiensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Artiodactyla		Indet. genus	indet. species	0	0	0	0	1	2	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	7	2	0	1	6	7
Sanitheriidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Sanitheriidae	?	Diamantohyus	jeffreysi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Listriodontinae		Listriodon	? Gupti	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	1
Kubanochoerinae	?	Libycochoerus	affinis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Anthracotheriidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2	1	0	0	0	1	2	1	0	5	9	29
Anthracotheriinae		Parabrachyodus	sp.	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthracotheriinae		Parabrachyodus	hyopotamoides	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microbunodontinae		Microbunodon	silistrense	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0
Microbunodontinae	?	Microbunodon	silistrense	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bothriodontinae		Sivameryx	palaeindicus	0	0	1	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	3	0	0	20	0	2	0	0	2	0
Bothriodontinae	?	Sivameryx	palaeindicus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	6
Bothriodontinae	cf	Elomeryx	borbonicus	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruminantia i.s.		Indet. genus	indet. species	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	8	0
Tragulidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	2	0	0	2	0	1	0	0	0	0	0	0	6	0
Tragulidae		Dorcatherium	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lophiomerycidae	?	New Genus	n. sp.	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
?Pecora, i.s.	?	Gelocus	gajensis	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pecora, i.s.		Bugtimeryx	pilgrimi	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	19	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pecora, i.s.	?	New Genus	n. sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pecora, i.s.		Progiraffa	exigua	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	2	0	0	0	0	2	0	1	1	4	2	4
?Bovoidea		Palaeohyspsodontus	zinensis	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Bovidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	19	1
Perissodactyla		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Chalicotheriidae		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0
Metamynodontini		Cadurcotherium	sp.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhinocerotidae		Indet. genus	indet. species	0	0	2	0	12	1	0	0	0	0	0	1	1	1	0	2	1	0	0	4	0	0	0	0	4	1	0	0	1	2	1	1	0	1	1	0	1	0	0	0	0	0	2	3	3	1	1	6	1	1	0	0	0	0	0	1	0	1	5	8
Aceratherini		Mesaceratherium	sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teleoceratini		Brachypotherium	fatehjangense	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Teleoceratini		Brachypotherium	gajense	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teleoceratini	cf	Brachypotherium	perimense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Menoceratinae		Pleuroceros	blanfordi	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Menoceratinae		Protaceratherium	sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Menoceratinae	?	Protaceratherium	sp.	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indricotheriinae		Indet. genus	indet. species	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aves		Indet. genus	indet. species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			number specimens:	1	1	8	1	20	324	46	3	3	2	4	13	1	3	1	4	1	1	231	37	1	58	42	1	25	1	2	3	3	14	3	3	81	11	3	3	1	4	9	1	1	2	3	67	6	1	14	18	7	257	3	1	1	30	12	16	1	15	179	63