E/1. Eames, F.E., 1950. The position of the Laki Limestone in the Eocene succession in West Pakistan. Geological Magazine 87(3), 214-216.

This paper does not strictly concerns the area of the present work, however, it is included as a compliment of a series of related papers by the author as given in the following.
It has previously been thought that in Sind the Meting Limestone Laki Limestone succession was equivalent to the Bolan Limestone, and that argillaceous beds, which are occasionally developed above the Laki Limestone and below the overlying Khirthar, represented the Ghazij Shales. Recent evidence indicates that these higher argillaceous beds are the representatives of the Shales with Alabaster of the Western Punjab, that in Sind the Ghazij Shales are cut out at the Laki/Ranikot unconformity, and that the Meting Limestone-Laki Limestone succession represents calcareous horizons higher up in the Laki series than the Bolan Limestone.
Key words: Stratigraphy, Laki Limestone, Eocene, Punjab, Sindh.

E/2. Eames, F.E., 1951a. A contribution to the study of the Eocene in Western Pakistan and Western India; Part A, The geology of standard sections in the western Punjab and in the Kohat District. Quaternary Journal of the Geological Society of London 107, 159-171.

Detailed descriptions are given of the geological successions in the Eocene of standard sections in the Rakhi Nala and at Zinda Pir in the western Punjab, and at Tarkhobi, Panoba, the Shekhan Nala and Sirki Paila in the Kohat district. The work forms the first stage in the reinvestigation of the classification and correlation of the Eocene in western Pakistan and western India. Comprehensive collections of fossils were made.
Key words: Stratigraphy, Eocene, Kohat, western Punjab.

E/3. Eames, F.E., 1951b. A contribution to the study of Eocene in Western Pakistan and Western India; Part B, The description of the lamellibranchia from standard sections in the Raki Nala and Zindapir areas of the western Punjab and in the Kohat District. Philosophical Transactions of the Royal Society of London, Series B, 235, 311-476.

Key words: Lamellibranchia, Stratigraphy, Paleontology, Eocene, Kohat, India.

E/4. Eames, F.E., 1952a. A contribution to the study of the Eocene in Western Pakistan and Western India; Part C, The description of the Scaphopoda and Gastropoda from standard sections in Punjab and Kohat District. Philosophical Transactions of the Royal Society of London, Series B, 236, 1-168

The Scaphopoda here described comprise three new species. The Gastropoda here recorded or described comprise 138 forms, 117 of which have received specific names. Of the 23 previously named species, two had not been recorded from Pakistan or India before. Largely owing to the nature of some of the beds from which collections were made, 96 of the species described are new. Four new genera and five new subgenera are proposed, and also one new generic name to replace a pre-employed name. The fauna recorded, together with the Lamellibranchia previously described, forms part of the material constituting the basis for the consideration of the classification and correlation of the Eocene of western Pakistan and western India, which the writer has published elsewhere.
Key words: Stratigraphy, Eocene, Paleontology, Scaphopoda, Gastropoda, Kohat, India.

E/5. Eames, F.E., 1952b. A contribution to the study of Eocene in Western Pakistan and Western India: D. Discussion of the faunas of certain standard sections and their bearing on the classification and correlation of the Eocene in Western Pakistan and Western India. Quaternary Journal of Geological Society of London 107, 173-200.

Local paleontological subdivisions are established for the Eocene of the Rakhi Nala, Zinda Pir and Kohat areas as a result of the examination of extensive collections of fossils recently made in these areas. The distribution of the different phyla in various facies developments is discussed. Comparison is made with the pre-existing major subdivisions of the Eocene in western Pakistan and western India. In the Rakhi Nala and Zinda Pir area, it is concluded that the Khirthar-Laki boundary has previously been taken at too low a horizon, and that beds previously referred to as lower Middle Khirthar include representatives of the upper Middle Khirthar, the Upper Khirthar, and still younger horizons of Upper Eocene age.

The lithological and mapping evidence and the paleontological evidence from the Rakhi Nala and Zinda Pir areas are each considered separately and finally synthesized in order to arrive at as precise a correlation as is possible. The evidence from the Kohat Eocene beds has been synthesized with that from the Rakhi Nala-Zinda Pir area in like manner, and it is evident that only the major palaeontological subdivisions can be correlated. The present investigations have confirmed the usefulness of the terms "Ranikot Series", "Laki Series" and "Khirthar Series" for subdivisions of the Eocene in western Pakistan and western India. The writer considers that the basic and fundamental soundness of these terms is not affected by the fact that beds and faunas have occasionally been incorrectly allocated to one or other of them. Certain beds, which are here named the "Tapti Series", and which are not of very widespread occurrence, contain a fauna which is distinct from that of the Khirthar Series below and is of Upper Eocene age. The fauna of this series, in addition to several species of Upper Eocene age and a number of new species, includes the genus Pellatispira, which is also of Upper Eocene age and has not yet been unquestionably recorded from horizons as low as those containing the genus Assilina.

A consideration of all the available evidence indicates that published information concerning the ranges of some species is incomplete and that in some cases the existing conception of a species requires modification. The author is of the opinion that the " zones " which have been previously proposed within the Ranikot, Laki and Khirthar Series are of local rather than regional value, and that there has been too great a readiness to assign regional chronological significance to local facies faunas. It is evident that further work is necessary before regional zoning of the series can profitably be attempted.

Key words: Paleontology, stratigraphy, Eocene, Rakhi Nala, Zinda Pir, Kohat.

E/6. Ebblin, C., 1976a. Tectonic lineaments in Karakorum, Pamir and Hindu Kush from ERTS Imageries. Rend Accademia Nazionale Dei Lincei, Series VIII (60), 245-253.

ERTS imageries have been used to map major lineaments, structural trends and faults of the region. Further information not available to us.

Key words: Tectonics, Karakoram, Pamir, Hindukush.

E/7. Ebblin, C., 1976b. Structural Geology of the Thalle Area, Baltistan, Karakorum, Central Asia. Nota I, Nota II. Published: Accademia Nazionale dei Lincei, Serie VIII, vol. LX, fasc. 5, 1976, 663-671 & fasc. 6, 1976, 853-857.

Key words: Structure, Baltistan, Karakoram.

E/8. Ebblin, C., 1976c. Geological structure of the Yasin-Ishkuman area, Central Asia. Records, Geological Survey of Pakistan, 43.

Key words: Structure, Yasin, Ishkuman, Karakoram.

E/9. Ebblin, C., 1978. Deformation in the area of the Pamirs-Himalayan syntaxis and strain patterns on the Earth's surface. Bollitin Geoessy Esc. Affini. 37, p.223.

Further information not available to us.

Key words: Structure, Pamirs, Himalaya.

E/10. Ebblin, C., 1982. Gravity profile along the middle Indus valley, northern Pakistan. Bollitin dei Geofisica Toerica ad Applicata 24, 39-55.

Key words: Gravity, Geophysics, Gilgit, Hunza.

E/11. Ebblin, C., 1983. Nature of the south Karakorum synclinorium. Bollettino di Geofisica Teorica ed Applicata (Pamir-Himalaya Volume) 25, 375-384.

Further information not available to the authors.
Key words: Structure, Karakoram.

E/12. Ebblin, C., Marussi, A., Poretti, G., Rahim, S.M. & Richardus, P. 1983. Gravity measurements in the Karakoram. Bollettin di Geofisica Teorica ed Applicata, Pamir-Himalaya, 25, 303-316.

Further information not available to the authors.
Key words: Gravity, geophysics, Karakoram.

E/13. Edmond, J.M., 1992. Himalayan tectonics, weathering processes, and the strontium isotope record in marine limestones. Science 258, 1594-1597.

The time evolution of the isotopic composition of seawater strontium (the ratio of strontium-87 to strontium-86) over the last 500 million years has the form of an asymmetric trough. The values are highest in the Cambrian and Recent (0.7091) and lowest in the Jurassic (0.7067). Superimposed on this trend are a number of smaller oscillations. Consideration of the geochemical cycle of strontium and the dynamics of weathering shows that only Himalayan-style continental collisions can influence the isotope ratio on the scale observed. The contemporary Himalayan orogeny is by far the largest since the late Precambrian Pan-African event that produced the high in the Cambrian.
Key words: Weathering, tectonics, geochemistry (isotope), marine limestones, Himalaya.

E/14. Edwards, M.A., 1998. Examples of tectonic mechanisms for local contraction and exhumation of the leading edge of India, southern Tibet and Nanga Parbat, Pakistan. Ph.D. Dissertation, State University of New York at Albany, 308p.

This is a detailed account of the structure and tectonics of the Nanga Parbat area. Attention has been paid to explain the rapid rise of the Himalaya during the late Tertiary and Quaternary. Some of the information has appeared in the publications of the author.
Key words: Structure, tectonics, Nanga Parbat, Himalaya.

E/15. Edwards, M.A., 1999. The "Marginal Areas" (e.g., Namche Barwa, Nanga Parbat, Tian Shan). Can they tell us anything truly significant about the collision? Terra Nostra 99, Abstract Volume, 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany, 44.

For the purposes of this discussion, regions that are not in the principal regions of the India Asia collision (i.e., Tibet and the Himalaya) are termed the "Marginal Areas". Under the term Marginal Areas are included (e.g.) Namche Barwa, Nanga Parbat, Tian Shan, all of which are being reported on elsewhere in the workshop.
Although the Marginal Areas have much to offer regarding tectonic interest in general, in particular because of the relatively recent nature of much of the tectonic activity, it is by no means clear if the recent accumulation of deformation in any of these areas is a predictable product of the India-Asia collision. Does the present information, and/or will further information significantly enlighten us as to the timing, thermal and mechanical evolution of the converging crust?
There are presently very active tectonics at Nanga Parbat at the western end ("syntaxis") of the Himalayan chain (e.g., 1.4 Ma age of Mazeno Pass leucogranite pluton at Nanga Parbat - Schneider et al., 1999), and also at Namche Barwa at the eastern end of the Himalayan chain (where cooling ages are also notably young, e.g., Burg, 1998). For Nanga Parbat, there is evidence to suggest that significant exhumation has been only within the last 10 Ma. -10 Ma

is also identified by some as an approximate date for the attainment of a gravitationally unstable thickness of the crust beneath Tibet. Are events at Nanga Parbat related to elevation increase in Tibet?

It has been proposed that there is a significant and predictable partitioning of strain, with arc-parallel extension accumulating at the in the "syntaxial regions" of the straining arc (Seeber & Pecher., 1998). It has been subsequently suggested that fossil Nanga Parbat-type features will be found in ancient collisional belts, and various types of modelling have been presented in which displacement or weakening is concentrated at the tips of the arc (e.g., Koons et al., submitted). On the other hand, it is known that a wide range of features can be generated by modelling using geologically reasonable input.

In the Tian Shan, there is some evidence for significant Late Oligocene exhumation (Hendrix et al., 1994). Modern exhumation rates in the Tian Shan are also high however, and these cannot have continued for the last ~25 m.y. How can these periods of deformation be a predictable or obvious result of the ongoing convergence of India & Asia?

Key words: Tectonics, collision, Nanga Parbat, Namche Barwa, Tian Shan.

E/16. Edwards, M.A. Kidd, W.S.F., Khan, M.A. & Schneider, D.A., 1998. Structural geology around southern Nanga Parbat; Synkinematic granite and truncation of MMT footwall in the SW, deformation styles in Rupal, and the Shonthar Thrust traced to the SE. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop, 61-64.

The Main Mantle Thrust (MMT) is the regional contact between collider India and the overthrust Kohistan-Ladakh fossil island arc in the Pakistan Himalaya2. The Nanga Parbat-Haramosh Massif (NPHM). Pakistan [NW Himalaya syntaxial region] is a tectonic half window of partly re-worked, largely Proterozoic, Indian plate rocks that have been exhumed from beneath Kohistan-Ladakh3. Early Himalayan age, general MMT thrust displacement is modified by very young (e.g. 1.4 Ma leucogranite Th-Pb ages4) tectonism at Nanga Parbat Haramosh Massif (NPHM). Our investigations in SW NPHM reveal a complex interplay of features related to (1) MMT-convergence, and (2) subsequent NPFW general uplift and tectonism.

In the area that is encompassed by the N-S trending Bunar valley, and NW trending Diamir valley, the main fabrics trend mostly N to NNE. In this area, the Indian "cover" passive margin rocks that form the original MMT footwall include sequences of carbonates and amphibolites (probably the Permian "Panjal Traps") interlayered with metapelites. In Diamir valley, these are not more than a few 100's metres thick. Here, the regionally NW-dipping cover sequences and MMT hanging wall (Kamila amphibolite) are overturned to become SE-dipping. These overturned layers are traceable to a recumbent open fold (the Gashit fold) in Airl Gah near the village of Gashit, where they form the upper (overturned) limb. The hinge line and axial plane of the fold plunge gently NS of this fold, the lower limb is exposed, thus sequences are not overturned and are observed to dip moderately to steeply west. The thickness of the cover sequence increases markedly to the south; carbonates, amphibolites and metapelites of several kilometres of structural thickness are present in the W-E Airl-Nashkin section, 10 km to the south of Diamir valley.

Structurally lower in the MMT footwall, and to the east (fig. 3), the cover sequence passes into a dominantly plutonic, ~5 km thick crystalline sequence that forms a continuous, ~30 km long, ~N-S belt with vertical to steeply E-dipping fabrics. The Diamir and Airl Gah (both ~W-E) valleys offer almost continuous outcrop sections through the belt. From these valleys, it is clear that a coarse-, to medium-grained biotite granite (the Jalhari granite) grades into granitic and porphyroclastic gneiss due to syn- to post-plutonism deformation. Jalhari leucogranite lenses (10's - 100's m thick) showing little to no sub-solidus deformation are separated by 10's - 100's m thick layers of gneiss where deformation of the granite has been localised. These higher strain layers anastamose around the granite lenses, and mark reverse faults that "climb" to the west. The granitic gneiss shows significant sub-solidus strain, including S-C porphyroclastic fabric whose sense of shear consistently indicates east side (NPHM) up and over west. Well-developed ductile/brittle shear bands and local fault gouge horizons, both of the same range of orientations as the ductile fabric, are also common. Late strain is often indicated by narrow (metres) zones where hydrothermal flux has developed thick biotite accumulations. Spectacular asymmetric folding (cm-wavelength) of the biotite layers indicates East Side up and over west. In the eastern portions of the Diamir valley section through the granite, a series of highly stretched, constant width (10-30 cm) amphibolite sheets can be followed for >100's m in continuous outcrop. These are parallel to sub-parallel to the deformed Jalhari granite. If these amphibolite sheets pre-date the granite, they imply a very large contrast in mechanical competence both during and after intrusion of the Jalhari granite. Th-Pb microprobe [UCLA's Cameca IMS1270] analyses of monazites separated from deformed and undeformed portions of the granite give ages ranging from 3-12 Ma.

Overall, the granite gneiss belt defines an N-S trending, W-vergent reverse sense shear zone ~5 km in width. We term this the Jalhari shear zone. The E over W displacement sense of the Jalhari shear zone is consistent with the development of the Gashit fold and with the upper limb that includes the overturned cover/MMT layers. This shear zone forms the mechanical continuation of the main Raikhot Fault (a NW-vergent reverse fault with NPHM in the hanging wal16). The Raikhot Fault is much narrower 5-km) however, and represents more focused strain.

The geology between the Jalhari shear zone and the central portions of massif is well exposed in the Diamir and Airl Gah valleys. The zone boundary is marked by brittle deformation within layers/lenses of retrograde (highly chloritised) metapelite. These then pass to more typical basement gneisses (e.g. showing metric banding due to differing Fe-weathering & biotite content). From here to Rupal valley, structures are more complex. Across Mazeno Pass, the 1.4 Ma4 pluton shows evidence of some normal motion associated with its emplacement. (Top to NW on steep, NW-dipping fabric). Principal gneissic fabric is N-NE trending. In places this is cut by quartz-pegmatites, and by leucogranite dykes that stem from the Mazeno Pass pluton. Some of the leucogranite dykes cross-cut the quartz-pegmatites, and in both cases, wall rock margins show normal sense of opening, but this may not be significant if (e.g.) the granite remained super-solidus during much of the strain.

Normal structures (top-to-NNW) are seen throughout Rupal valley. All, however, are brittle, probably very late, and of minor displacement. Most are developed on older thrust planes that are ~W-E trending, the western portion of the Rupal Chichi Shear Zone (RCSZ7). There is vast thickness of orthogneiss in Rupal showing top to SSE thrusting. The NW-dipping fabric is continuous throughout the Rupal Face, biotite gneiss dips ~43oNW at the summit of Nanga Parbat. The Rupal Face is very steep. Locally, a ~2 km thick leucogranite with irregular margins intrudes western Rupal Face, above Shaigiri village (between -5000 & ~6800 m). This may be emplaced in the axial zone of a tight antiform with NW-dipping axial surface, and whose axial trace passes to the south side of the summit ridge. This antiform is seen on Chongra ridge (again NW-dipping) and can be traced to the "western antiform" (Edwards & Kidd, 1997) described from the Astor Gorge. In both of the valley walls, amphibolite, coloured marbles and metapelites are found as fairly homogeneously deformed meter-scale layers/lenses within the extensive orthogneisses. At lowest elevations in the valleys walls of central Rupal, numerous thick fault gouge zones are seen, possibly indicating that at least part of Rupal valley has provided a (topographic) local crustal weakness to focus late brittle deformation. In the southern portions of western Rupal (in Shaggin Glacier valley, and all along the south side of Rupal & Toshain Glaciers) gneissic fabric dips SW to S and shows excellent SW stretching lineation, typically with a clear top-to-SSW sense of shear. Intrusive, now-L-tectonised granite pods7 pre-date this fabric, which may be very young.

Part of our continuing work in Chichi Nullah (SE NPHM) has included mapping of the southern portion of the RCSZ whose margin is well exposed here. It is sub-parallel to the Chichi Nullah and marked by a contact between the non-coaxially sheared granitic orthogneiss (continuous north to central Rupal) and the extensive marbles, amphibolites and metapelites of local Indian plate cover sequences. The foliation of the cover rocks and the gneisses are largely parallel, and orientation switches from NW dipping (overturned) in northern Chichi, through vertical, to SE-dipping in southern Chichi. This is another example of southern NPHM "bulging out" in cross sectional view (c.f.7) In southernmost Chichi, within the locally SE-dipping marbles and amphibolites, several reverse faults define a >200m wide, NW-vergent thrust zone. This is most spectacularly expressed by a clear box fold (box = 10's m2 area of section) within the zone. The thrust is observed to continue SW over the southern wall of Chichi Nullah. It's surface trace can be drawn from here and confidently joined with the Shonthar (Gali) thrust that has been mapped in Azad Kashmir near the Pak-lndo Line of Control8, 9. Also noteworthy is that in southern Chichi, the sheared orthogneiss of the RCSZ dies out. This is replaced (further south) by a largely undeformed, fine-grained leucogranite of several 100's km2 area. The (apparently intrusive) margin of the granite does not visibly cut the foliation of the country rock (i.e. marbles). Close to the margin, the granite shows minor sub-solidus deformation; however, we found no part of the granite that can be termed gneiss. The granite forms dull brown craggy towers along the tops of the valley walls, exactly like the sheared orthogneiss to the NE. We are investigating whether the granite and the orthogneiss may be originally related in some manner.

Key Words: Structure, tectonics, Indus suture, Synkinematic intrusions, Nanga Parbat, Himalaya.

E/17. Edwards, M.A. & Kidd, W.S.F., 1997. Structural investigation around southern and eastern Nanga Parbat. Abstract volume, 12th Himalaya-Karakorum-Tibet International Workshop, Rome, Italy, 29-30.

The western Himalaya syntaxis includes the Indian-plate Nanga Parbat Haramosh (NPHM). The contact between collider India & the overthrust Kohistan series (KLS) is regionally termed the Main Mantle Thrust (MMT). It forms a plan-view, “oxbow” shape around NPHM, yet NPHM is not a relict promontory of India that has acted as a horizontal indenter and “bowed out” the visible MMT. This is recognized by the absence of appropriate deformation of the northern margin of the KLS (Pecher et al., 1996). NPHM has enjoyed accelerated exhumation form beneath the KLS since ca. 10 Ma (Zeitler, 1985; Zeilter et al., 1993), and locally plutonism has been constrained as young as 1.4 Ma (Schneider et al., 1996), tens of kilometers of crustal section are required to have been removed from above Nanga Parbat. This has prompted speculation (e.g. Hubbard et al., 1995) that the NPHM may be another Himalayan core complex (c.f. Nyainqentanglha-Pan and Kidd, 1992).

Our structural mapping in the eastern and southern massif, coupled with geochronologic analysis, and previous mapping in NPHM (e.g. Butler et al., 1992) indicates that recent NPHM exhumation (<10 Ma) is not due to significant unroofing via a low-angle normal faulting. Large amounts of mass have not been tectonically denudation from NPHM drainage area.

Along the oblique (~NW-SE) NPHM section formed by the Astor River gorge, two antiforms with different lithology are apparent. The western antiform is asymmetric with thinned E-limb. The eastern antiform is asymmetric with a thinned W-limb. Both axial planes trend ~N-S. These thinned limbs mark the Dashkin Synform, a pulled-down isoclinal fold whose axial plane trends ~N-S, and dips steeply W. Migmatitic orthogneiss dominates the W antiform Cross-cutting amphibolite dykes are more frequent close to the thinned limb. The KLS is exposed in the hills 2-3 km above the Astor Gorge on the crests of both antiforms. There is no petrographic evidence for part of the KLS in the core of the Dashkin synform within 1000m of exposure above the river, although obliteration due to stretching of the synform remains possible.

Gneisses and schist in the eastern antiform are steadily N-S trending, vertical to steeply dipping, with lineation typically plunging gently N. These rocks are largely non-granitic/migmatitic, and there is no magmatism which post-dates the N-S lineation that we (as others, e.g. Butler et al., 1992) regard as original fabric due to either thrust or normal motion on the MMT (Edwards et al., 1996). The sequence of gneisses and schists that from the E limb of the eastern antiform has been divided into several mappable units, including the KLS rocks at the contact. This sequence is fully continuous from Astor gorge north over Dichil Gali to the Indus gorge, and to the south. We mapped this sequence in seven ~E-W valleys between Astor village and Rattu. Nowhere was the NPHM-KLS contact marked by a significant brittle structure nor any evidence of significant kinematics features not attributable tot the MMT. Between Astor Village and North Lower Rupal, the NPHM-KLS contact sequence dips 40-80º E. From South Lower Rupal to near Rattu, the sequence is overturned and dips 40-80º W: the NPHM here is “bulging out”.

We infer W side up; thrust sense localized ductile displacement to be represented by the Dashkin synform based upon the relative differences in height of the overlying KLS rocks and the migmatitic gneisses in the western antiform. Interpreted satellite imagery (TM, SPOT) shows this zone continuing and widening to Chongra glacier and the Rupal-Chichi shear zone (see below) where a strain is much greater. The two contrasting synforms are not inconsistent with the most recent data from the equivalent NPHM section along the ~W-S Indus gorge (Wheeler et al., 1995).

The Rupal-Chichi Shear Zone is a several km wide belt of granitic orthogneiss showing a pervasive. NW side up with dextral shear indicated by augen asymmetry and S-C fabric. Associated overprinting lineation plunges ~30-60ºSSW to WSW. Foliation shows some change: NE-trending in Chichi; NNE trending at Tarshing; ~ W-E trending near Tapp Meadow. Dip is to the north. Kinematics indicated by this pattern are consistent with SE “corner” of Nanga Parbat moving up and NE relative to the eastern margin. There appears to be a large contrast in ages across this zone (Schneider et al., this volume). West of Tapp Meadow to Toshe Gali at the head of Rupal valley (~20 km) there is a return to ~N-S trending foliation and lineation.

In the central Rupal Valley there is an increase in (deformed) granitic component to the gneiss, greater on the south side. It is noteworthy that the more granitic areas appear to be concordant to the local (regional?) ~N-S fabric and yet analyses of preliminary samples give <5 Ma (Schneider et al., this volume). Other areas of “unstrained” granite crosscut the local fabric. The Mazeno Pass pluton (~5400m) emplaced at 1.4 Ma (Schneider et al., this volume), is discordant to the local fabric. In Upper Rupal Valley there is large contrast in fabric: N-dipping lineation in more rich gneisses on the N side, as opposed to SW plunging lineation in gray gneisses on the S side that contain large (Dm-scale) pods or boudins of lineation parallel granitic L-tectonic. Although foliation in the gray gneisses is steep and NE trending, and although the SW-plunging lineation may be a rotated MMT (originally N dipping) structure, there may have been some top to SW shear in this area. To the SW is Azad Kashmir, outside of the NPHM drainage area, and this is a part of the massif where some tectonic exhumation could have occurred.

Between the NPHM-KLS contact near the mouth of Lower Rupal valley and the Rupal-Chichi shear zone at Tarshing, is found the Churit Fault. The Churit Fault is a diffuse zone of steep, W side up N-S trending brittle faults

~1.5 km wide. The fault juxtaposes sillimanite grade orthogneiss in the west over staurolite grade metapelites in the east. The Churt Fault lacks significant ductile overprinting of regional N-S lineation, and seems to represent relatively minor exhumation of the massif.

We conclude that deformation for NPHM is largely indicative of a pop-up structure. This is evidenced by (1) NE-vergent folding visible along the Astor section, and (2) overturning of the eastern margin of southern NPHM, consistent with greater differential uplift indicated by (3) the W or NW side up, E-vergent Churit and Rupal-Chichi structures. This is consistent with NW vergent, NE dipping thrust structures on the western margin (e.g. Raikhot/Liachar) that form the corresponding western part of the pop-up structure. Our proposal of an asymmetric pop-up (Edwards et al., 1996) is consistent with preliminary data from the seismic experiment (Meltzer et al., 1996) that indicate that the Raikhot/Liachar system continues as the SE dipping basal thrust below the massif soleing to an area of dense seismicity that is truncated at 6 km below sea level. This is consistent with a model envoking large NW-trending relative surface velocities for either the entire western Himalaya (e.g. McCaffrey & Nabalek, 1996) or simply at the syntaxis, due to arc parallel extension (Seeber et al., 1996).

Key words: Structural geology, Nanga Parbat.

E/18. Edwards, M.A. & Kidd, W.S.F., 1999. New map of southern Nanga Parbat. Terra Nostra 99, Abstract Volume, 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany, 43-44.

A new structural and lithologic map (as part of the Nanga Parbat Continental Dynamics Project) has been made for the southern Nanga Parbat area in the Pakistan Himalaya. About 90% of the mapped area was hitherto unreported in recent geological literature, the remaining 10% being covered by preliminary or work.

The portions of the massif where mapping was conducted include: (Clockwise from Mazeno Pass) Diamir, Bunar, Biji and Jalhari Gah area (in the SW), the Astor Gorge and Dichil Gah-including the two tributaries that intersect the Eastern margin, Rama, Bulan and Ghurikot Gah areas (including the two northern tributaries of Ghurikot Gah), The Lower Rupal Valley (Tarshing Area) and northern Rattu valley, Chichi valley (to the foot of the pass to the Kishanganga) and central and Upper Rupal areas (to the foot of Toshe Gali and up to and over Mazeno Gali).

Three major findings include (1) a major new shear zone, the Rupal-Chichi Shear Zone, (2) the Diamir-Rupal Shear Zone-a significant continuation of the Raikot system for >60 km to the SW, and (3) that the original MMT on the east side has not been significantly modified or displaced, only rotated to vertical (for all three see Edwards et al., and Schneider et al., this issue). The map originally appeared in Edwards (1998).

Key words: Structure, lithology, mapping, Nanga Parbat.

E/19. Edward, M.A., Kidd, W.S.F., Khan, M.A. & Schneider, D.A., 2000. Tectonics of the SW margin of the Nanga Parbat-Haramosh massif. In: Khan, M.A., Treloar, P.J., Searle, M.P. & Jan, M.Q. (Eds.), Tectonics of the Nanga Parbat Syntaxis and the Western Himalaya. Geological Society, London, Special Publication 170, 77-100.

We present an analysis of the tectonic evolution of the southwestern portions of the Nanga Parbat massif, Pakistan Himalaya, based upon detailed mapping and structural analyses from the Bunar, Biji, Diamir, Airl, Niat and SW Rupal valleys. Mainly metasedimentary cover rocks of the Indian plate are divided into upper and lower cover. There is a marked structural thinning of the cover in the main Bunar valley from south to north, and this is attributed to a major frontal ramp in the original Main Mantel Thrust (MMT). A hitherto unmapped shear zone, the Diamir Shear Zone, is identified, that is associated with a syn-kinematically intruded belt of granitic rocks, the Halhari Granite. The shear zone is a several kilometer thick, generally W-vergent, ductile to brittle shear zone that is associated with local overturning of the entire MMT section, typified by the Gashit Fold. 40Ar/39Ar cooling ages from across the area indicate as steep cooling age gradient across the Diamir Shear Zone from >40 to <5 Ma. The Diamir Shear Zone is mechanically linked to part of the Raikhot Fault System and, together, they are seen to be crustal-scale reverse fault that has allowed relative uplift and overthrusting of the core of Nanga Parbat.

Key words: Tectonics, Nanga Parbat, Himalaya.

E/20. Edwards, M.A., Kidd, W.S.F., Khan, M.A., Schneider, D.A., Zeitler, P.K. & Anastasio, D., 1997. Structural geology of the southwestern margin of Nanga Parbat. EOS, Transaction of the American Geophysical Union 78, F651.

The Main Mantle Thrust (MMT) is the regional contact between collider India and the overthrust Kohistan-Ladakh series in the Pakistan Himalaya. Early Himalayan-age thrusting and some later (~20 Ma?) normal motion on/near the MMT is modified by very young (e.g. 1.4 Ma leucogranite Th-Pb ages) tectonism at Nanga Parbat-Haramosh Massif (NPHM); the Himalaya's western syntaxis. Our investigations in southwestern NPHM reveal a complex interplay of MMT-related (mostly convergent) structural features followed by those related to uplift and tectonism of NPHM. Across the Diamir/Bunar area, main fabrics trend N to NE. In Diamir Valley, Indian cover passive margin metapelites and carbonates in the MMT footwall are not more than a few 100’s of metres thick. Here, the regionally NW-dipping Indian cover sequences and MMT hanging wall (Kamila amphibolite) are overturned (SE-dipping). These overturned layers are traceable to the Gashit fold, whose hinge line plunges ~N and axial surface dips gently-moderately east. The cover sequence thickness increases markedly to the south; several km structural thickness of carbonates, metapelites and amphibolites are present in the W-E Airl-Nashkin section, only 8 km to the south of Diamir valley. The cover sequence passes east into a dominantly plutonic 5-10 km thick crystalline sequence where coarse to fine grained granite (the Jalhari granite) grades, due to syn- to post-plutonism deformation, into granitic and porphyroclastic gneiss intercalated with gneissic basement. Regionally the cover and crystalline rocks follow the subvertical to steeply E-ESE dipping foliation, and displacement sense is consistently east side (NPHM) up and over west. Within Diamir valley, granitic and gneissic foliation, shear bands, and local fault gouge zones anastamose around less- to un-deformed Jalhari granite lenses of 10-100’s metres width. Plutonism seems to be in part synkinematic, and may provide an older age limit for NPHM tectonism. The E over W sense is consistent with the development of the Gashit fold and the upper limb that includes the overturned cover/MMT layers. The sharp attenuation of the cover sequence in northern Bunar valley could be a result of excision by normal motion along the MMT but we find no compelling evidence for this. We propose that the attenuation is a result of (1) a large frontal ramp in the MMT and an underlying related duplex largely of Indian cover and/or (2) original MMT thrust belt morphology where a lateral ramp-related duplex system has imbricated (and/or infolded) local thin slices of the cover and basement.

Key words: Structural geology, Nanga Parbat.

E/21. Edwards, M.A., Kidd, W.S.F., Seeber, L., Pêcher, A., LeFort, P., Riaz, M., & Khan, M.A., 1996. An upwardly–mobile indentor? The Nanga Parbat Haramosh Massif viewed as a crustal–scale Pop–up structure. EOS, Trans., American Geophysical Union, 77, F692.

The western Himalaya syntaxis [Fig 1] includes the Indian-plate Nanga Parbat Haramosh Massif (NPHM) [Fig 2]. The contact between collider India & the overthrust Kohistan-Ladakh series (KLS) is regionally termed the Main Mantle Thrust (MMT). It forms a plan-view, “oxbow” shape around NPHM, yet NPHM is not a relict promontory of India that has acted as a horizontal indenter and “bowed out” the visible MMT. This is recognised by the absence of appropriate deformation of the northern margin of the KLS. Pervasive lineation in NPHM is ~N-S, and sense of shear on the eastern margin is often dextral where recognised. Although this agrees with horizontal indentor model predictions, the broadly antiformal nature of NPHM allows the steep N-S foliation near the margins to be the result of rotation of the original, ~E-W, gently north-dipping MMT system about an axis ~parallel to the pervasive lineation. Therefore, the eastern margin and dextral shear sense, respectively, can be restored and recognised as top-to-south, MMT zone Himalayan thrust structures, largely unaltered. Observations now extending to seven main valleys confirm that there is no large brittle fault defining the eastern NPHM-KLS contact; the contact is essentially unmodified MMT. The antiformal nature of the massif is illustrated by the degree of apparent exhumation. Within NPHM, exhumation of the central portions of the massif (e.g. Nanga Parbat) has formed a complete window through Indian plate cover sequence schist and gneiss (garnet-staurolite grade) into basement gneiss (sillimanite grade ±granulite facies, cordierite-bearing anatectic segregations). This exhumation has been accommodated in part by large ductile and brittle shear zones within SE NPHM. The Rupal Shear Zone is a wide belt of ~N-S trending orthogneiss showing a pervasive, west side up with dextral shear S-C fabric and overprinting lineation. Closer to the eastern margin, the Churit Fault in lower Tarshing valley juxtaposes sillimanite (?) grade orthogneiss in the west over staurolite grade metapelites in the east, but lacks significant ductile overprinting of regional N-S lineation. Near Raikot, the original MMT contact of the western margin is largely obscured by east-over-west thrusting with some overprinting the regional ~N-S lineation. Qualitative changes in the relative development of some fault and shear zone features may indicate diminishing strain to the north. Within NPHM and in Kohistan, late, NW-vergent structures dominate (young pegmatitic dyke sets, fault propagation folds, antithetic faults) and are suggestive of an asymmetric pop-up or flower structure. The NW-vergence in NPHM late brittle structures is consistent with the direction of axes of maximum compression derived from brittle fault kinematics in both crystalline and quaternary rocks near and west of the Raikot fault. Our evidence confirms and strengthens the view that NPHM is an asymmetrical antiformal structure, verging NW.

Key words: Structure, tectonics, Nanga Parbat.

E/22. Edwards, M.A., Schneider, D.A., Kidd, W.S.F., Khan, M.A. & Zeitler, P.K., 1999. Summary of selected tectonic and geochronologic observations arising from the Nanga Parbat Continental Dynamics Project. Terra Nostra 99, Abstract Volume, 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany, 40-41.

The Nanga Parbat Continental Dynamics Project (c.f., Zeitler et al., this volume) employed various disciplines (e.g., Meltzer et al., this volume) to investigate the tectonic processes that have contributed/contribute to present situation at the Nanga Parbat Haramosh Massif (NPHM). This is a summary of some of our tectonic and geochronologic observations in Central and SE NPHM.

Astor valley and SE NPHM: Two antiforms (with broadly differing overall lithology) are observed in the main Astor Gorge; the Burdish Ridge and Dichil antiforms, in the west and east, respectively. The Burdish Ridge antiform is asymmetric with a thinned E-limb, while the Dichil antiform is asymmetric with a thinned W-limb. This is recognised by a very tight, pinched fold morphology of the accompanying (Dashkin) syform. The Iskere gneiss (Madin, 1986; Madin et al., 1989; Treloar et al., 1991) is present near the core of, and west of, Burdish Ridge antiform as a series of 100's m to < 2-km sections interlayered with the porphyroclastic and coarsely to finely laminated, occasionally calc-silicate gneisses. We suggest that the discontinuous nature of the Iskere gneiss in Astor Gorge compared to the Indus Gorge (ibid.) is largely due to "fingering" (thinning / pinching out of multiple tabular or elongated peripheral portions) of the edge of the main body that is seen along the Indus Gorge, and we note that the bodies should, in principle, be traceable northward to join the Indus Gorge main body (possibly in a non-continuous fashion, if certain lskere layers are km-scale boudins or lenses). The original intrusive contact of the Iskere protolith may have been either inter-fingering or may have been planar.

The Dichil antiform includes various conspicuous gneisses and schists that can be followed (discontinuously) through the (~W-E trending) valleys of SE NPHM, including (e.g.) the "lath unit" (Edwards, 1998; Edwards & Kidd, this volume; Schneider et al., this volume; Argles et al., this volume; Foster et al., this volume). These form the footwall of the original MMT and present therein are impressive high strain zones related to both original MMT thrust-sense, and, locally, to MMT-normal sense (!) displacement (ibid.). There is no significant displacement fabric related to the uplift of NPHM, only overturning of the previous "high Himalayan" fabric that is part of the "bulging out of southern NPHM.

NPHM-uplift-related shear zones in the SE: The Rupal-Chichi shear zone (RCSZ) is a km-scale, dextral, W-side up, high strain zone defined by a continuous belt of non-coaxially sheared granitic orthogneiss with impressive C/S fabrics along its entire length. This hitherto unrecognised feature is a fundamentally important discovery for constraining the tectonics of NPHM; it is now clear that the RCSZ has acted as the conjugate, "retro-' shear zone to the southern Raikhot & Diamir shear zone system (see below) to define a crustal scale pop-up structure. Displacement along the RCSZ may have migrated "inwards" to the centre of the massif based upon the ages of (1) cross-cutting leucocratic\-granitic dykes, and (2) total fusion Ar/Ar biotite-cooling ages of the orthogneiss, both of which show an overall younging towards the centre of the massif (Schneider et al., this volume - a & b). To the south of the RCSZ is the newly discovered early Miocene Southern Chichi leucogranite pluton (ibid.).

Shonthar Thrust: North and east of the Southern Chichi pluton, the cover sequences are marked by extensive marbles, amphibolites and metapelites of local Indian plate cover sequences. The foliation here switches from NW dipping (overturned) in northern Chichi, through vertical, to SE-dipping in southern Chichi. This may mark the southern limit of the NPHM "bulging out". Within the locally SE-dipping marbles & amphibolites, several reverse faults define a >200m wide, NW-vergent thrust zone. This is expressed by a clear box fold (box 10's m area of section) within the zone. The thrust is observed to continue SW over the southern wall of Chichi Nullah. Its surface trace can be drawn from here and confidently joined with the Shonthar (Gali)'thrust that has been mapped in Azad Kashmir near the Pak-lndo Line of Control.

Deformation in Rupal: Normal structures (top-to-NNW) are seen throughout Rupal valley. All, however, are brittle, probably very late, and of minor displacement. Most are developed on older thrust planes that are ~W-E trending; the western portion of the Rupal Chichi Shear Zone (RCSZ). There are vast thickness of orthogneiss in Rupal showing top to SSE thrust sense-of-shear. The NW-dipping fabric is continuous throughout the Rupal Face; biotite gneiss dips ~45°NW at the summit of Nanga Parbat. Locally, a ~2-km thick leucogranite with irregular margins intrudes the very steep western Rupal Face, above Shaigiri village (between ~5000 & ~6800 m). This may be emplaced in the axial zone of a tight antiform with NW-dipping axial surface, and whose axial trace passes to the south side of the summit ridge. This antiform is seen on Chongra ridge (again NW-dipping) and can be traced to the “western antiform” described from the Astor Gorge. In both of the valley walls, amphibolite, coloured marbles and metapelites are found as fairly homogeneously deformed metre-scale layers/lenses within the extensive orthogneisses. At lowest elevations in the valleys walls of central Rupal, numerous thick fault gouge zones are seen, possibly indicating that at least part of Rupal valley has provided a (topographic) local crustal weakness to focus late brittle deformation. In the southern portions of western Rupal (in Shagin Glacier valley, and all along the south side of Rupal & Toshain Glaciers) gneissic fabric dips SW to S and shows excellent SW stretching lineation, typically with a clear top-to-SSW sense of shear. Intrusive, now-L-tectonised granite pods pre-date this fabric. The orientation, petrographic texture, and sense of shear of the fabric resembles the mylonitic and high strain zones of the MMT footwall that we see elsewhere. We note that the top-to-SSW sense of shear is best explained by rotation (from ~N-dipping) of the original MMT thrust-displacement fabric; such a rotation is to be anticipated here on the SW flank of the uplifting massif.

The brittle normal faulting seen in a number of places in the massif indicates that the central part of southern NPHM is in a state of extension near the surface. It seems that there is a small value for normal stress on existing fractures of many orientations, and that only a small rotation of the stress field is required to switch from reverse to normal motion on pre-existing fault surfaces. Some focal mechanisms for resolvable seismic events within southern NPHM are consistent, showing extensional first motions occurring to ~6-km depth (Meltzer et al., this volume). Note, however, that there is no evidence for large-scale tectonic exhumation of NPHM.

Key words: Structure, tectonic, geochronology, Nanga Parbat.

E/23. Edwards, M.A., Schneider, D.A., Kidd, W.S.F., Khan, M.A. & Zeitler, P.K., 1999. Summary of selected tectonic and geochronologic observations in SW NPHM arising from the Nanga Parbat continental dynamics project. Terra Nostra 99, Abstract Volume, 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany, 42-43.

This abstract is a summary of some of tectonic and geochronologic observations in SW NPHM arising from the Nanga Parbat Continental Dynamics Project (Zeitler et al.).

Truncation of cover sequence: In the area that is encompassed by the N-S trending Bunar valley, and NW trending Diamir valley, the main fabrics trend mostly N to NNE. In this area, the Indian “cover” passive margin rocks that form the original MMT footwall include sequences of carbonates and amphibolites (probably the Permian “Panjal Traps”) interlayered with metapelites. In Diamir Valley, these are not more than a few 100’s metres thick. Here, the regionally NW-dipping cover sequences and MMT hanging wall (Kamila amphibolite) are overturned to become SE-dipping. These overturned layers are traceable to a recumbent open fold (the Gashit fold) in Airl Gah near the village of Gashit, where they form the upper (overturned) limb. The hinge line and axial plane of the fold plunge gently N. South of this fold, the lower limb is exposed, these sequences are not overturned and are observed to dip moderately to steeply west. The thickness of the cover sequence increases markedly to the south; carbonates, amphibolites and metapelites of several km of structural thickness are present in the W-E Airl-Nashkin section, 10 km to the south of Diamir valley.

The abrupt northward thinning of cover sequences in SW NPHM is orders of magnitude too large to be original depositional variation and there must be some type of tectonic excision. Large amounts of STDS-type normal motion have not been reported from the MMT. Similarly, we have found no compelling evidence around NPHM for large-scale normal motion on the MMT (the MMT-normal motion seen in SE NPHM cannot account for several km of exhumation). Consequently, we suggest that a large-scale frontal ramp in the original MMT gave rise to a local duplex structure that imbricated thin slices of cover, and possibly basement. This model is consistent with our mapping in Niat Gah, the next main valley to the west of NPHM, where a basement slice occurring close to the MMT implies large-scale imbrication of the cover sequences.

Jalhari Granite synkinematic in Diamir Shear Zone: Structurally lower in the MMT footwall, and to the east, the cover sequence passes into a dominantly plutonic, ~5-km thick crystalline sequence that forms a continuous-alongstrike (>30 km), ~N-S belt with vertical to steeply E-dipping fabrics. The Diamir and Airl Gah (both ~W-E) valleys offer almost continuous outcrop sections through the belt. From these valleys, it is clear that a coarse-, to medium-grained biotite granite (the Jalhari granite) grades into granitic and porphyroclastic gneiss due to syn- to post-plutonism deformation. Jalhari leucogranite lenses (l0s-l00s m. thick) showing little to no sub-solidus deformation are separated by 10's-100's m thick layers of gneiss when deformation of the granite has been localized. These higher strain layers anastamose around the granite lenses, and mark reverse faults that climb to the west. The granitic gneiss shows significant sub-solidus strain, including S-C porphyroclastic fabric whose sense of shear consistently indicates east side (NPHM) up and over west. Well-developed ductile/brittle shear bands and local fault gouge horizons, both of the same range of orientations as the ductile fabric, are also common. Late strain is often indicated by narrow (metres) zones where hydrothermal flux has developed thick biotite accumulations. Spectacular asymmetric folding (cm-wavelength) of the biotite layers indicates east side up and over west. Th-Pb ion microprobe [UCLA's Cameca IMS 1270] analyses of monazites separated from deformed and undeformed portions of the granite give ages ranging from 2-8 and 12 Ma, respectively (Schneider et al., this issue). Overall, the granite gneiss belt defines a N-S trending, W-vergent, reverse sense shear zone ~5-km in width. We term this the Diamir Shear Zone. The E over W displacement sense of the Diamir Shear Zone is consistent with the development of the Gashit fold, and with the upper limb that includes the overturned cover/MMT layers (again note that here on the NPHM SW flank the massif is again "bulging out" in cross-sectional view). The Diamir shear zone forms the mechanical continuation of the main Raikhot Fault: at Raikhot Bridge, where last seen, the structure is marked by a NW-vergent reverse fault with NPHM in the hanging wall (Madin, 1986; Madin et al., 1989). The Raikhot Fault is much narrower (<<5-km) however, and represents more focused strain. We interpret the emplacement of the Jalhari granite to be at least partly syn-kinematic with exhumation of NPHM, intruded in discrete episodes between 2 and 12Ma.

Eastern margin of Diamir Shear Zone and Mazeno Pass section: The geology between the Diamir Shear Zone and the central portions of massif is well exposed in the Diamir and Airl Gah valleys. The zone boundary is marked by brittle deformation within layers/lenses of retrograde (highly chloritised) metapelite. These then pass to more typical basement gneisses (e.g. showing metre-scale layering due to differing Fe-weathering & biotite content). From here to Rupal Valley, structures are more complex. Across Mazeno Pass, the 1.4 Ma pluton (Schneider et al., this volume) shows evidence of some normal motion associated with its emplacement. (top to NW on steep, NW-dipping fabric). Principal gneissic fabric here is N-NE trending. In places this is cut by quartz-pegmatites, and by leucogranite dykes that stem from the Mazeno Pass pluton. Some of the leucogranite dykes cross-cut the quartz-pegmatites, and in both cases, wall rock margins show normal sense of opening, but this may not be significant if (e.g.) the granite remained super-solidus during much of the strain.

Conclusion: In conjunction with our observations of Central and SE NPHM (Edwards et al., this issue), we conclude that the uplift of the NPHM massif is accommodated upon two conjugate shear zones that define a pop-up structure. The RCSZ (on the eastern flank) is the "retro" structure while the Raikhot Diamir system (on the western flank) is the "pro" or "dominant" structure. The overturning (bulging out) of the massif is occurring on both flanks, however this occurs out with the main shear zone on the eastern flank (away from the centre of the massif); this is consistent with an overall more-diffuse focus of strain in the retro shear zone. We have recognized original "high Himalayan" features in the areas out with of central NPHM, including (I) the original MMT, and (2) evidence for Early Miocene plutonism that is ubiquitous to the main Himalaya and hitherto unrecognised in the NW Himalaya.

Key words: Tectonic, geochronology, Nanga Parbat,

E/24. Egerton, R.E., 1969. Note on the effects of earthquake of November 10, 1967, at Bannoo. Proceedings, Asiatic Society of Bengal, 163-164.

Further information not available to the authors.

Key words: Seismicity, earthquake, Bannu.

E/25. Eguchi, M., 1965. Cretaceous corals from the eastern Hindu Kush. In: Matsushita, S. & Huzita, K. (Eds.), Geology of the Karakoram and Hindu Kush. Results of the Kyoto University Scientific Expedition to the Karakoram and Hindu Kush (1955) 7, 131-136. Nippon Printing & Publishing Co., Ltd., Japan.

This is a study of two samples of corals, one of which was collected from Yasin group at the type locality and the other from the Green series at Rawat, east of Shamran. The former is identified as genus Eugyra, suggesting a Lower Cretaceous age for the Yasin Group. The one from the green series is genus Thamnasteria, found in Jurassic and Cretaceous rocks.
Key words: Corals, Greenstones, Yasin Group, Gilgit, Eastern Hindu Kush.

E/26. Ehsan, F., Nisar, A., Siddiqui, F.A. & Khan, A.H., 1983. Chemistry and mineralogy of some Eocene and associated limestones of Kohat District, N.W.F.P. Pakistan Journal of Scientific and Industrial Research 26, 212-219.

Key words: Geochemistry, mineralogy, limestone, Eocene, Kohat.

E/27. Elahi, H.I., 1994-96. Geological mapping of Dunga Gali to Kuza Gali, Khanpur Area, and Site investigation of Ghazi-Barotha Hydro-Power Project, District Abbottabad, NWFP. M.Sc. Thesis, Punjab University, Lahore, 47p.

The area mapped and studied is located in the form of a strip extending between Dunga Gali and Barian in the Northwest Himalayas (ca, 33° 57"-34° 4"N, 73° 23"-73° 25"E). The area falls mainly in Abbottabad, administrative district of N.W.F.P It is located on the survey of Pakistan Toposheet no 43 5/8 and 43 G/5.
Key words: Stratigraphy, hydel power, Abbottabad, Hazara.

E/28. Elahi, M.K. & Martin, N.R., 1961.The physiography of the Potwar, West Pakistan. Geological Bulletin, University of Punjab 1, 5-14.

The highly dissected plateau of the Potwar is a clearly defined and well-Known Physiographic region of West Pakistan, with a distinctive landscape. An attempt is made to divide it into physiographic units, and to show the close relationship of the geology and minor landforms.
Key words: Geomorphology, physiography, Potwar.

E/29. Elahi, S.M., 1962. Geology of Abbottabad area, Hazara. M.Sc. Thesis, Punjab University, Lahore.

This is an account of the geology, lithology and stratigraphy of the Abbottabad area, along with a preliminary geological map.
Key words: Stratigraphy, Abbottabad.

E/30. Elbersen, C.W.W., 1967. Reconnaissance soil survey of Peshawar Valley, Peshawar and Mardan Districts. Soil Survey Project of Pakistan.

Key words: Soil science, reconnaissance, Mardan, Peshawar.

E/31. Engineers Combine Limited, Lahore, 1979. Preliminary mineral survey in Kotli and Poonch districts of Azad Kashmir. Report Prepared for Azad Kashmir Mineral & Industrial Development Corporation, 1, 25-58.

Note: Engineer Combine Limited, Lahore, a private company, produced a series of reports on mineral occurrences of the North-West Frontier Province and Azad Jammu and Kashmir. These reports are not readily available. However, parties interested in further exploration and exploitation of these mineral can obtain the relevant repot from the provincial/state directorates.
Key words: Mineral survey, Kotli, Poonch, Azad Kashmir.

E/32. Engineers Combine Limited, 1975. A survey report on the selected minerals of the northwest Frontier Province. Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar.

Key words: Mineral survey, NWFP.

E/33. Engineers Combine Limited, 1977. Detailed geological investigations of nepheline syenite of Koga area, Swat, 111p. Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar.

Key words: Syenite, Koga, Swat.

E/34. Engineers Combine Limited, 1977. Preliminary survey report on marbles, manganese, asbestos, mica, pyrite and corundum of North West Frontier Province, 130p. Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar.

Key words: Economic geology, mineral deposits, NWFP.

E/35. Engineers Combine Limited, 1977. Detailed geological investigation of China clay of Timargara (Dir) and Ahll (Hazara) area. Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar, 95p

Key words: Economic geology, Mineral deposits, Dir, Hazara.

E/36. Engineers Combine Limited, 1978. Preliminary investigations of minerals along the borders of Dir and Swat, 191 p. Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar.

Key words: Economic geology, Dir, Swat.

E/37. Engineers Combine Limited, 1978. Malakand graphite; Detailed geological investigations 1, 176 p. Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar.

Key words: Economic geology, mineral deposits, graphite, Malakand.

E/38. Engineers Combine Limited, 1978. Malakand graphite; Detailed geological investigations 2 (maps and annexures only). Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar.

Key words: Economic minerals, graphite, Malakand.

E/39. Engineers Combine Limited, 1978. Preliminary mineral survey in Kotli and Poonch Districts of Azad Kashmir. Azad Kashmir Mineral and Industrial Development Corporation, 1, 249p, & 2, 161p.

Key words: Minerals, Poonch, Kotli, Azad Kashmir.

E/40. Engineers Combine Limited, 1979. Delineation of low iron bearing zones of nepheline syenites, Koga area, Swat, 185 p. Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar.

Key words: Syenite, Iron Ore, Koga, Swat.

E/41. Engineers Combine Limited, 1979. Exploration of magnetite and other minerals in Allai Kohistan, 174 p. Directorate of Industries Commerce and Mineral Development, Government of North West Frontier Province, Peshawar.

Key words: Magnetite, Allai, Kohistan.

E/42. Etheridge, R., 1864. Note on the Jurassic fossils collected by Captain Godwin Austen. Quarterly Journal of the Geological Society, London, 20.

Key words: Paleontology, Karakoram.