H/1. Habib, M., Pervez, J. & Rehman, S., 1982-83. Petrography of the Thor and Thorly mafic ultramafics association Chilas complex, Northern Pakistan. M.Sc. Thesis, University of Peshawar, 116p.

The huge Chilas complex is predominantly occupied by rather uniform gabbronoritic rocks locally amphibolitized along shear zones. In the Chilas, Thurly and Thor area, there are many small bodies of mafic-ultramafic rocks showing complex relations with the host gabbronorites. This is a detailed account of the geology, field relationships, and petrography some bodies in thurly-Thor area, together with a carefully prepared geological map.
Key Words: Petrography, Mafic-ultramafic rocks, Chilas complex, Kohistan.

H/2. Haddle, J.F., 1855. Memoir on the River Indus. Bombay Government Sel., Record New Series 17.

Key Words: Indus River, India.

H/3. Hadi, S., Abbasi, I.A., Khan, M.A. & Shah, M.R., 2000. Structure and stratigraphy of the collision related Main Boundary Zone, Thal area, Western Kohat. Late Abstracts, Third South Asia Geological Congress, Lahore, p.8.

For further details consult the following account.
Key Words: Structure, stratigraphy, MBZ, tectonic mélange, Thal, Hangu.

H/4. Hadi, S., Abbasi, I.A., Khan, M.A. & Shah, M.R., 2001. Tectonostratigraphy along the western collision zone Thal area, western Kohat, NW Pakistan. Abstracts, 4th Pakistan Geological Congress, Islamabad, 26-27.

The mélange zone and carbonate sequence exposed around Thal area defines the western most intersection of the Main Boundary Thrust (MBT) and the Kuram Boundary Zone (KBZ) that records the imprints of the western oblique collision of the Indian Plate with Afghan block. The associated deformation due to these structures in the area has bimodal nature. The first phase is syn-ophiolite obduction, which brings the Shahur Tangi-Kahi Group over the Indian shelf sequence as a thrust sheet with large aerial extent, and is contemporary to Paleocene as constrained by the highly brecciated and attenuated Lockhart Formation. The younger phase of deformation associated with Main Boundary Thrust (MBT) and uplift of the Kurram Boundary Zone (KBZ) caused the Indian shelf sequence (Isha Group) to breach out along the high angle south verging structures e.g. Kliadii-nak & Darsamand structures. This phase is believed to be post-Pliocene as it deforms the young conglomeratic deposits of the molasse sequence.
The lsha Group (Jurassic-Paleocene) is comprised of Sainanasuk/Chiltan, Chichali/Lumshiwal, Kawagarh and Lockhart formations. The Shahur Tangi-Kabi Group represents a sub-CCD flysch olistostromal sequence and is sub-divided into Ahni Tangi, Shinki Post and Khajuri Post formations of the Late Cretaceous age. The Eocene rocks are represented by shale/limestone sequence (Panoba Shale & Kohat Limestone) that unconformably overlies the post-ophiolite obduction thrust stack and marks the western extremities of the Eocene Kohat Basin where most of the Eocene rock taper out. Thick molasse sequence of the Kohat foreland basin unconformably overlies the Eocene rocks and is represented by Kamlial, Chinji & Nagri formations.
Key Words: Tectonics, stratigraphy, collision, Thal, Kohat.

H/5. Hafeez, M.A. & Ahmad, S.A., 1992. Status of geological mapping on 1:50,000 scale in Pakistan. Geological Survey of Pakistan, Information Release 535.

Information is provided on status of mapping by the Geological survey of Pakistan at a scale of 1: 50,000 in various areas of the country.
Key Words: Geological mapping.

H/6. Hallam, A. & Maynard, J.B., 1987. The iron ores and associated sediments of the Chichali Formation (Oxfordian to Valanginian) of the Trans-Indus Salt Range, Pakistan. Journal of Geological Society, London 144, 107-114.

A distinctive and widespread belemnite-bearing shale of the Tethyan region is well exposed in the Trans-Indus Salt Range as the Chichali Formation, where it contains two workable ironstone seams. Facies analysis indicates a pronounced deepening in the Upper Oxfordian and Kimmeridgian followed by two regressive cycles marked by a transition from glauconitic–phosphatic shales to glauconitic silts and sands and finally to winnowed and oxidized glauconitic sandy ironstones. The first cycle ends in Berriasian belemnite-rich beds; the second cycle, which has few belemnites, extends into the Valanginian, and is followed by deltaic sediments of the Lumshiwal Formation.
Comparison with other areas indicates that the source area for the clastic components was the Indian Shield to the east and south. The increased clastic supply in the Upper Jurassic–Lower Cretaceous is thought to result from tectonic uplift in this source area rather than from climatic change.
The ironstone beds are distinctive in being pelletal glauconites compared with the oolitic chamosite and goethite so typical of the Jurassic elsewhere. Enrichment of the glauconite to commercial grade was by winnowing and oxidation on the seafloor. The absence of oolitic chamosite and goethite could be related to generally deeper water and an overall Eh in the environment too high to allow iron to migrate in appreciable quantities as Fe2+.
Key words: Economic geology, iron ore, sedimentary rocks, Chichali Formation, Trans-Indus Salt Range.

H/7. Haller, H., 1937. Ein relief der Nanga Parbat-gruppe. Mitteilungen des Deutschen und Osterreichischen Alpenvereins 11, 168-170.

Key words: Geomorphology, Nanga Parbat.

H/8. Hameed, A., 1992-94. Sedimentary petrology/sedimentology of Early Cretaceous Lumshiwal Formation and Early Palaeocene Lockhart limestone and lithostructural mapping of Sirgah area, southern Hazara, Pakistan. M.Sc. Thesis, Punjab University, Lahore, 150p.

A comprehensive study of Geology and structure of Dhamtaur area is represented along with special constraints on the sedimentology of Lumshiwal Formation of Early Cretaceous and Margalla Hill Limestone of Early Eocene. Large scale (1:10000) Geological mapping of a small segment of the Lesser Himalaya in the Dhamtaur area is presented. The lithostratigraphic unit range from upper Paleocene to Pre-Cambrian, Hazara Formation being the oldest. Structurally the area comprises NW-SE trending major anticlinorium. The folds are tight to isoclinal and opposing southeast and North West vergence on the two sides of the core formation. Some anticlines show plunge to the southeast direction. Almost all faults have vergence parallel to the folds developed in the core on the two sides of the main anticlinorium. Most are reverse faults although some may be of the normal type. Faulting appears to be dipslip to oblique slip and in general involves a maximum displacement of few hundred meters.
A detailed study of sedimentary petrology/sedimentology of Lumshiwal Formation of Early Cretaceous and Lockhart Limestone of Early Paleocene has been carried out. The object was to study the petrography environment of deposition and diagenesis of the above said formations.
The section of Lumshiwa1 Formation from Jhamiri village between Haripur-Jabrian Road is medium to thick bedded glauconite sandstone. This formation is divided into nineteen microfacies. The microfacies overlying Chichali formation is glauconite, iron oxides and quartz cemented, quartz arenite. The other microfacies are mainly quartz, glauconite and carbonate cemented, and mature to super mature quartz arenites. The maximum development of glauconiteis from central to upper part. Upper horizons are selectively cemented with flint.
The Lumshiwal Formation indicates low energy conditions in the subtidal zone. The formation of glauconite itself reveals slow rate of sedimentation and mildly reducing conditions. Diagenetic history indicates the formation of glauconite, secondary quartz, feldspar and flint earlier and ferroan calcite and dolomite at a later stage. The last stage involves the formation of ferroan dolomitization which occurred during final uplift with parts convening into dedolomites.
The section of Lockhart Limestone near Ghumawan is medium to thick bedded. The Lower contact of Lockhart is disconformable with Hangu Formation and upper contact of Lockhart Limestone with Patala Formation is sharp and

conformable. This section is comprise of 25 microfacies and 4 facies ranging from mudstone, wackestone and packstone; have been defined on the basis of field observation and petrographic studies.
The deposition of Lockhart Limestone took place in open marine shallow shelf conditions. Neomorphism of syndepositional micrite has taken place under various conditions during different phases of tectonic activity. Mechanical and chemical compaction are present in the forms of aligned fauna and stylolites. The porosity is generally low. The type of porosities are fracture and vug.
Key words: Iron ore, sediments, Chichali Formation, Salt Range.

H/9. Hamid, K.A., Ahmad, K.S. & Shah, M.S., 1980. Geology of Muzaffarabad area, Azad Kashmir. M.Sc. Thesis, University of Peshawar, 86p.

Key words: Geology, Muzaffarabad.

H/10. Hamidullah, S., 1984. Asbestos occurrence in Mohmand Agency: Genesis, economics, and related health hazards. Geological Bulletin, University of Peshawar 17, 69-73.

Two new localities of asbestos are reported from Mohmand Agency. It is considered that the asbestos development is associated with shearing and circulation of water and some CO2 in ultramafic rocks. The asbestos is of considerable economic significance, however, there is strong circumstantial evidence that its related health hazards have already started affecting the local miners.
Key Words: Minerals, asbestos, ultramafics, Mohmand Agency.

H/11. Hamidullah, S., 1991. Chemistry of clinopyroxene from the Deosai volcanics, Baltistan, N. Pakistan. Geological Bulletin, University of Peshawar 24, 161-176.

Seventy analyses of clinopyroxene phenocrysts from the Deosai volcanics were obtained and tested for substitutions and other petrogenetic characters. The data shown an overall core-margin substitution of $xCa+xNa+xFe^{3+} + xtAl +xTi= xSi+xMg+xFe^{2+}+ xMn$ type in the phenocrysts, with “x” representing the actual amount of a cation entered or replaced, and which can be determined precisely from its variation along with unit variation of Si. The data also indicate crystallization in a temperature range of 1100 – 1200ºC, under highly variable pressure, from a basaltic magma of alkaline (but transitional to non-alkaline) characters.
Key Words: Mineralogy, chemistry, pyroxene, Deosia, Baltistan.

H/12. Hamidullah, S., 1994a. Chemistry of hornblendes from the Deosai volcanics, Baltistan, northern Pakistan. Geological Bulletin, University of Peshawar 27, 1-8.

Seventy eight core to margin spot analyses of 8 hornblende phenocrysts from an andesitic basalt of Deosai plateau, Baltistan. N. Pakistan, are presented in the form of means and standard deviations. The data show an igneous parentage for these hornblendes. Chemical variations do not agree with commonly accepted substitutions for igneous hornblendes and an overall core to margin substitution of $[xFe^{3+}x^{iv}Al+xTi+xMg+xNaB = x^{iv}Al+xFe^{2+}(\pm xMn)+xCa+xSi+xA\text{-site}]$ type is suggested with the former set of cations higher in cores and the latter in margins. A tentative temperature range of 875-700^{0}C and a PH_2O range of 6-4.2 kb are suggested for the crystallization of these hornblendes. It is also suggested that like clinopyroxene the Deosai hornblendes carry unusual chemical features which may be related to variations in physio-chemical environment of the magmata chamber, and for that reason, possibly, of the source region.
Key Words: Chemistry, hornblende, volcanics, Deosai, Baltistan

H/13. Hamidullah, S., 1994b. The Waziristan complex: some more chemical data and their interpretation. Geological Bulletin, University of Peshawar 27, 69-79.

Tholeiitic and cal-alkaline affinities are reflected by two different rocks from the Waziristan island arc in 22 major element rock analyses. Previously published clinopyroxene analyses are used for comparison. The data confirms the existence of a fossil island arc in Waziristan.
Key Words: Geochemistry, Island arc, Waziristan.

H/14. Hamidullah, S., 2000. Geology and mineral chemistry of the Deosai volcanic, Baltistan, N Pakistan. Abstract Volume, 15^{th} Himalaya-Karakoram-Tibet Workshop, (Chengdu) China, p.416.

The westerly extension of the Dras volcanics in the Deosai plateau of Baltistan, northern Pakistan, lying east of the Nanga Parbat-Haramosh Massif, is comprised of agglomerates and tuffs together with flows consisting of basalt, andesite and some rhyolite. In the filed these volcanics are overlying the Ladakh batholith and both these basic and acidic suites of rocks carry the signatures of the Nanga Parbat-related orogeny. The flows appear to have evolved from a basaltic magma, with opaque oxide, clinopyroxene, hornblende and plagioclase, respectively appearing on the liquidus. These have been metamorphosed under greenschist facies conditions and may contain abundant epidote, chlorite and secondary amphibole. Metamorphic impact seems to be stronger in the west, i.e., in the vicinity of Nanga Parbat-Haramosh Massif, than in the east. An $^{40}Ar/^{39}Ar$ age of 125.4 ± 6 Ma on hornblende phenocrysts in an andesite is in agreement with the Late Jurassic to Cretaceous age of the Dras volcanics, in India, and indicates that Nanga Parbat related tectonics may have played a part in the growth of lower green schist facies assemblage of the volcanic rocks.
Though the various chemical discrimination plots of the clinopyroxene phenocrysts show them as representing igneous parentage, with crystallization in a temperature range of 1100-1200°C, under highly variable pressure, from a basaltic magma of alkaline (but transitional to non-alkaline) characters, these data however, show substitutions which do not agree with the commonly accepted ones for clinopyroxenes from igneous rocks. Therefore, an overall core-margin $vCa+vVa+vFe^{3+}+vtAl+vTi$ -- $vSi+vMg+vFe^{2+}+vMn$ type substitution has been suggested for these phenocrysts, with 'v' representing the actual amount of a cations entered or replaced, and which can be determined precisely from its variation along with unit variation of Si. Similarly the hornblende phenocryst chemical data also show igneous characters but with variations which do not agree with commonly accepted substitutions for igneous hornblendes. Therefore an overall core to margin substitution of $[Fe^{3+}+{}^{iv}Al+Ti+Mg+NaB = {}^{vi}Al+Fe^{2+}(\pm Mn)+Ca+Si+A\text{-site}]$ type is suggested with the former set of cations higher in cores and the latter in margins. A tentative temperature range of 875-700°C and a PH2O range of 6-4.2kb are suggested for the crystallization of these hornblendes. It is also suggested that like clinopyroxene the Deosai hornblendes carry unusual chemical features which may be related to variations in physio-chemical environment of the magmatic chamber, and for that reason, possibly of the source region triggered by subduction along the main Mantle Thrust.
Key Words: Geology, mineral chemistry, Deosai, Baltistan.

H/15. Hamidullah, S. & Ahmad, A., 1992. Pseudo-amphibolites in the southern amphibolite belt, Kohistan arc, N. Pakistan. Geological Bulletin, University of Peshawar 25, 73-76.

More evidences strengthening the view of the existence of (a) pseudo-amphibolite forming as a result of reaction between pre-granitic hornblendite or amphibolite and the granitic magma and (b) of certain hornblendites forming as a result of reaction between pre-granitic amphibolite and the granitic magma, in the southern amphibolite belt of the Kohistan island arc, are presented in this paper.
Key Words: Amphibolites, Kohistan, Island arc.

H/16. Hamidullah, S., Bangash, I.H. & Reuber, I., 1990. Petrology of the southern amphibolite belt rocks from Mahak and surrounding area, Kohistan arc, north Pakistan. Geological Bulletin, University of Peshawar 23, 27-43.

The various rock types of Mahak are medium- to coarse -grained amphibolites, hornblendites, hornblende pegmatite, diorites, meta-gabbro, metapyroxenite and quartzo-feldspathic veins and dykes. Amphibolites are most abundant rocks of the area. These are distinguished into epidote amphibolite and plagioclase amphibolite. The major element chemistry of the amphibolites suggests their derivation from a basic igneous parent of tholeiitic character,

but field data also indicate some of them to be hybrids having been developed as a result of reaction between hornblendites and the granitic magma. The true amphibolites contain mineral assemblages indicating amphibolite grade metamorphism followed by the prevalence of epidote amphibolite facies and a minor phase of green schist facies environments. Hornblendites are usually monomineralic. Two types of hornblendite occur, i.e. (a) pre-granitic and the common ones and (b) sys-granitic. Field and laboratory data show that the former types may be representing early cumulate for the basic amphibolites or rocks having been formed in the loci of fluid phases during the amphibolite grade metamorphism. However, field evidence show that the sys-granitic hornblendites are the product of reaction between amphibolites and the granitic magma.
Key Words: Petrology, amphibolites, Mahak, Kohistan Arc.

H/17. Hamidullah, S. & Hussain, I., 1990. Geochemistry and petrology of the southern amphibolite belt rocks from Mahak and surrounding area, Swat, North Pakistan. Abstracts, 2nd Pakistan Geological Congress, University of Peshawar, p.24.

Part of the amphibolite belt rocks around Mahak area in upper Swat has been investigated for petrogenetic interpretation. The petrology of the rocks indicates their production as a result of the combined igneous, metamorphic and metasomatic activity. The major igneous activity was followed by amphibolite facies and green schist facies metamorphism, indicating retrogression. Limited metasomatic and/or igneous activity took place together with or followed by the major metamorphic episode.
Key Words: Petrology, Amphibolites, Mahak, Kohistan Arc.

H/18. Hamidullah, S. & Ihsan, M., 1977. Mineralogy and petrology of the Shergarh Sar complex, Allai Kohistan, Hazara. M.Sc. Thesis, Peshawar University, 32p.

Key Words: Petrology, Shergarh, Kohistan, Island Arc.

H/19. Hamidullah, S., Islam, F. & Farooq, M., 1991. Petrology and geochemistry of the western part of Kalam-Dir igneous complex, Kohistan arc, northern Pakistan. Physics and Chemistry of the Earth, 17, 31-46.

Key Words: Petrology, Geochemistry, Kalam, Dir, Kohistan, Island Arc.

H/20. Hamidullah, S., Jabeen, N., Bilqees, R. & Jamil, K., 1986. Geology and petrology of the Malakand granite, gneiss and metasedimentary complex. Geological Bulletin, University of Peshawar 19, 61-76.

The Malakand granite intrudes a series of low-grade metasediments and granitic gneisses. It appears to be Calc-alkaline in characters. A temperature range of c. > 875-6500C and PH_2O of c. 5 <5 kb has been suggested for the development of various phases in the granite. The chemical features and age relationship also indicate that the Malakand granite is not genetically related to the alkaline igneous complex of the Peshawar Plain.
Three types of gneisses have been distinguished; a) siliceous gneiss, b) silica-rich granitic gneiss and c) normal granite gneiss. Among these only the normal granitic gneiss seems to be genetically related to the Malakand granite. The metasediments indicate several episodes of regional metamorphism ranging from lower green-schist facies to upper green-schist facies environments. The presence of garnet in schist at the contacts of granite has been related to the thermal effects of the intruding granitic magma.
Key Words: Petrology, granite, gneiss, Malakand.

H/21. Hamidullah, S. & Jan, M.Q., 1986. Preliminary petrochemical study of the Chilas complex, Kohistan island arc, northern Pakistan. Geological Bulletin, Univ. Peshawar 19, 157-182.

The Chilas complex, stretching more than 300 km and reaching 40 km in width, consist predominantly of gabbronorites with minor pyroxenites, anorthosites and quartz diorites containing labradorites / andesine. Within these are found upto 4 km^2, seemingly intrusive, masses of dunite-peridotite-troctolite-anorthosite association characterised by the presence of bytownite / anorthite. Sixty four new chemical analyses reflect a genetic relationship among the various rock types. The data suggest crystallization from an arc-related parent magma of calcalkaline character. The oxides vs. D. I. And CMAS plots indicate olivine, orthopyroxene, and plagioclase as the dominant liquidus phases for the development of rocks varying from ultramafic through mafic to intermediate compositions. It is concluded that crystallization occurred possibly at a depth of < 25 km followed by pyroxene granulite facies metamorphism. This was followed by widespread amphibolitisation during uplift. The masses of ultramafic and related rocks appear to be early cumulates that were remobilized and emplaced into the main gabbronorite association.
Key Words: Petrology, geochemistry, Chilas complex, Kohistan.

H/22. Hamidullah, S., Jan, M.Q. & Khan, Barkatullah, 1992. Petrography of the Deosai volcanics, N, Pakistan. Geological Bulletin, University of Peshawar 25, 17-22.

The western extension of the Dras volcanics in the Deosai plateau is made up of agglomerates and tuffs together with flows comprising basalt, andesite and some rhyolite. The flows appear to have evolved from a basaltic magma, with opaque oxide, clinopyroxene, hornblende and plagioclase, respectively appearing on the liquidus. These have been metamorphosed under greenschist facies conditions and may contain abundant epidote, chlorite and secondary amphibole. An ^{40}Ar / ^{39}Ar age of 1125.4 ± 6 Ma on hornblende phenocrysts in an andesite is in agreement with the Late Jurassic to Cretaceous age of the Dras volcanics.
Key Words: Petrography, volcanics, Deosai, Baltistan.

H/23. Hamidullah, S. & Jehan, N., 1999. From asbestoses to silicosis: a new turn in the story of the disease-causing mineral industry of Northern Pakistan. Abstracts, International Conference on Sustainable Management of Natural Resources, Department of Geology, University of Peshawar-UNESCO, p.49.

Key Words: Asbestosis, silicosis, mineral industry, Mohmand Agency.

H/24. Hamidullah, S. & Jehan, N., 2001. Further data on environmental impacts of silica industry in Mohmand Agency, N. Pakistan. Abstracts, 4th Pakistan Geological Congress, Islamabad, p.65.

Key Words: Silica industry, environmental hazard, Mohmand Agency.

H/25. Hamidullah, S., Jehan, N. & Arshad, J., 1999. Asbestos in northern Pakistan and its possible role in malignant mesothelima. Souvenir and Abstracts, 4th Biennial International Conference on Chest Diseases and Tuberculosis, Organized by Pakistan Chest Society, 35-36.

Key Words: Asbestos, health hazard.

H/26. Hamidullah, S., Khan, M.S. & Shah, M.T., 1998. Heavy metal pollution in the western part of Peshawar Metropolis, north Pakistan. Journal of Nepal Geological Society 18, 379-394.

Key Words: Heavy metals, pollution, Peshawar.

H/27. Hamidullah, S. & Khan, M.J., 1993. Two clinopyroxenes from Upper Swat: Their chemistry and its petrogenitic implications. Geological Bulletin, University of Peshawar 26, 35-43.

Two sets of clinopyroxene analyses, one from the andesites of Utror volcanics and other from a troctolite patch in diorite from Deshai, Upper Swat, are used to ascertain the magmatic affinity and tectonic setting of their host rocks. Both the sets indicate igneous crystallization in island arc-related orogenic environments. Clinopyroxene data from the volcanic rock indicate calcalkaline affinities, while, those from troctolite appear to have grown from tholeiitic magma.
Key Words: Chemistry, petrogenesis, clinopyroxenes, Swat.

H/28. Hamidullah, S. & Onstot, T.C., 1992. ^{40}Ar/^{39}Ar evidence for late Cretaceous Formation of the Kohistan Island Arc, NW, Pakistan. Kashmir Journal of Geology 10, 105-122.

Hornblende, biotite and plagioclase separates from Kalam-Dir igneous complex, Kohistan Island Arc, NW Pakistan, have been analyzed by the ^{40}Ar/^{39}Ar technique. Hornblende from the volcanics and diorite plutons of Gabral (near Kalam) and Dir areas and biotite from tonalite at Matiltan yield dates ranging from 74 to 54 Ma, whereas other biotite and one of the plagioclase separates from the diorite plutons at Gabral yield 44 to 39 Ma plateau dates. Plagioclase from another diorite of Gabral and one form the ultramafic rock unit of Mahodand are contaminated by excess argon.
These date indicate that the Late Cretaceous to Early Eocene period was dominated by calc-alkaline plutonic magmatism (represented by diorites) accompanied by a short span of calc-alkaline volcanism (Kalam-Dir volcanics) at about 70 Ma, in the northern Swat and Dir areas. The ages increase progressively southward. Each major magmatism and/ or volcanism has caused high-grade metamorphism of already crystalline rocks in the south. The culmination of magmatism in the Kalam-Dir area at 54 Ma probably resulted from the collision of the Kohistan Island Arc with India.
The 45-39 Ma dates of the biotite and plagioclase from the diorites of Gabral reflect a middle Miocene to Oligocene metamorphism followed by cooling due to uplift and erosion in the area, and may represent the after-effects (extensional environments) of collision of Kohistan Island Arc with India. Alternatively, they may reflect the collision of the combined Indian and Kohistan Arc plates with that of Eurasia (along the MKT).
Key Words: Geochronology, Ar/Ar dates, Gabral diorite, Utror volcanics, Kohistan island arc.

H/29. Hamidullah, S., Saifullah, M. & Shah, M.T., 1997. Heavy metals concentrations in the soils of Peshawar metropolis. Abstracts, 3rd Pakistan Geological Congress, University of Peshawar, p.16.

Part of the information is given in Hamidullah et al., 2000.
Key Words: Heavy metals, soil, Peshawar.

H/30. Hamidullah, S., Saifullah, M. & Shah, M.T., 1997. Heavy metal pollution in the eastern part of Peshawar, metropolis, Environ. Pollut. 3rd National Symposium, Abstract No.111.

Consult the following account for further information.
Key Words: Heavy metals, pollution, Peshawar.

H/31. Hamidullah, S., Saifullah, M. & Shah, M.T., 2000. Heavy metal pollution in soils of Peshawar city, NWFP, Pakistan. Geological Bulletin, University of Peshawar 33, 1-9.

Soil samples from I0 locations in Peshawar city have been analyzed for heavy metals including Cr, Co, Ni, CU, Zn, Fe and Pb in order to evaluate the impact of heavy metals pollution reported earlier in the air, surface clay and sewerage system of Peshawar city by Hamidullah et al., (1997). It is concluded that heavy metals found in the dust fall of the city 012 the roadsides have so fur not reached the soil horizon. The relative enriched Cr in the soils

compared to the heavy metals data of the corresponding air samples, reported earlier, has been attributed to the source material including the rock of the Main Mantle Thrust and Kohistan Island Arc. Higher Fe in these soils has been attributed to the process of soil formation. It has been warned that though heavy metals do not directly percolate into the soil horizon within the city at an alarming rate, these metals make their way from surface through the sewerage system of the city and via Budni Canal to Kabul River which is the feeder of the underground water system in Peshawar Basin. The indirect potential threat of heavy metals pollution to the subsurface strata of the basin does exist and needs to be blocked.
Key Words: Heavy metal, pollution, Peshawar.

H/32. Hamidullah, S. & Shah, M.T. 1993. Textural and minerachemical significance of hornblendes from an andesite at Dir, Kohistan arc, N, Pakistan. Geological Bulletin, University of Peshawar 26, 45-58.

Petrography and minerachemical features of a hornblende andesite from Gira Khwar, northeast of Dir proper, are studied to envisage the crystallization mode of hornblende phenocrysts, in the rock. It is determined that the cores of the hornblende phenocrysts are primary igneous. On the other hand the bluish green rims of these phenocrysts and probably the groundmass hornblende are a product of subsolidus re-equilibrium and or metamorphic recrystallization. The very tips of the hornblende phenocrysts appear to have recrystallized during shearing and cataclasis at a latter stage.
Key Words: Petrography, mineral chemistry, andesite, Dir, Kohistan arc.

H/33. Hamidullah, S., Shah, M.T. & Khan, M.A., 1996. Identification and characterization of the quality of silica sand resources from Munda Gucha, district Mansehra, in glass making. Geological Bulletin, University of Peshawar 29, 59-68.

The silica sand deposit of Munda Gucha area occurring in the quartzose rock of Tannawal Formation, district Mansehra, has been mapped and sampled for identification and characterization of its quality for glass making. Petrographic, geochemical and field studies show that the Munda Gucha silica sand deposit has tremendous potentials as a source of silica sand for glass, steel, soap and ceramic industries. With previous studies suggesting inferred reserves of 70 million metric tones and an average SiO2 between 90-95 %, the present data has enhanced the average SiO2 to 95.21%. Samples collected from the snow white zone of Bela Sukian block along Munda Gucha-Jacha road have maximum SiO2 content of 99.7 % and those from Mohri have 98.84 %, providing to be useful in manufacturing of first quality optical glass. On the basis of grain size (0.3-0.5 mm in diameter) the Munda Gucha silica sand stands the best standard known in Pakistan. It is concluded that the deposit has tremendous potential as source of silica sand for glass, steel, soap and ceramic industries. Simple or very dilute acidic washing is suggested for the removal of tFe2O3 because of its occurrence as surfacial iron leaching.
Key Words: Economic geology, Silica sand, Munda Gucha, Mansehra.

H/34. Hamidullah, S., Tariq, S., Saifullah, Khan, M.S., 1999. Environmental studies in and around Peshawar Metropolis with special reference to heavy metals pollution. Souvenir and Abstracts, 4th Biennial International Conference on Chest Diseases and Tuberculosis, Organized by Pakistan Chest Society, p.33.

Consult Hamidullah et al., 2000, for information.
Key Words: Heavy metal pollution, Peshawar.

H/35. Hamidullah, S., Tariq, S. & Shah, M.T., 2001. Soil pollution in the western part of Peshawar basin. Abstracts, 4th Pakistan Geological Congress, Islamabad, p.45.

Nineteen samples from horizon A (0-20 cm depth) and 18 samples from horizon B (20-45cm depth) of the soils from various spots of the western part of Peshawar basin were analysed for major elements, certain trace elements and heavy metals in order to (a) compare these soils with soils from other parts of the world, (b) determine if any

contamination is existing and (c) to identify the source of such a contamination. The data show that $Si0_2$, Al_2O_3 and Fe_2O_3 stand normal in these soils. MgO, CaO, Na_2O, K_20, and P_2O_5 of these soils are however, higher than the limits given for normal soils by the United States Department of Agriculture (USDA, 1957). Similarly, heavy metals including Cu, Pb, Ni and Cr are high in these soils when compared with international limit. The reasons for high concentrations of CaO, Na_2O, K_2O are water logging and salinity arid for high MgO, Cu, Ni and Cr, the availability of source material in the nearby Skhakot Qua ultrarnafic complex. Similarly, the high concentration of P205 may also be due to the presence of this element in the P205 bearing rocks at the northern extremities of the basin at Selai Patai (Malakand - Mohmand junction) or the overuse of phosphate-bearing fertilizers in the agricultural practices. The source of Pb in soils at certain locations may be both i.e. source rocks arid industry.
Key Words: Soil pollution, Peshawar.

H/36. Hamidullah, S., Zahid, M. & Majid, M., 1991. Mineralogy and mineral chemistry of the amphibolite belt and Main Mantle Thrust Rocks from Gantar area, Allai Kohistan, north Pakistan. Geological Bulletin, University of Peshawar 24, 133-146.

Petrographic and mineralogical studies are performed for the Kohistan island arc, MMT mélange zone and Indian plate lithologies at Gantar village and in its surroundings, in Allai Kohistan, Hazara. Petrographic studies reveal that locally, the Kohistan island arc lithology is exclusively comprised of amphibolites and epidote amphibolites with certain patches of hornblend pegmatites. The MMT mélange zone includes greenschist and blueschist whereas the Indian plate sequence is made up of a variety of schistose rocks and siliceous marble. Petrography and mineral chemistry indicate that amphibolites have an igneous parentage and have undergone successive metamorphic episodes of amphibolite facies, epidote-amphibolites facies and greenschist facies, in a temperature range of $530 \leq 500^{o}C$ and a pressure range of $6 \leq 4.5$ kb, whereas the MMT mélange zone rocks show signature of amphibolite facies, blueschist facies (7kb) and greenschist facies metamorphic episodes. The hornblend pegmatite patches in amphibolites are interpreted as products of low pressure metasomatism, on the basis of lower viAl content in hornblende as compared to that in amphibolites. Small outcrops of metagabbro and metanorite found in the area are regarded as part of the island arc system, on the basis of their clinopyroxene chemistry. Structural, petrographic and mineral-chemical features indicate a subduction-obduction related petrogenesis for these rocks.
Key words: Mineralogy, chemistry, amphibolite, MMT, Allai Kohistan.

H/37. Hamidullah, S., Zahid, M. & Majid, M., 1992. Petrology and geochemistry of the mélange zone and southern amphibolite belt rocks from Gantar area, Allai Kohistan, Hazara, Pakistan. Abstracts, First South Asia Geological Congress, Islamabad, p.15.

Consult the preceding account.
Key Words: Petrology, geochemistry, Mélange, amphibolite, gantar, Allai, Kohistan.

H/38. Hammarstrom, J.M., 1989. Chemistry of emeralds and some associated minerals from Pakistan and Afghanistan; An electron microprobe study. In: Kazmi, A.H. & Snee, L.W. (Eds.), Emeralds of Pakistan: Geology, Gemology and Genesis, 125-150. Van Nostrand Reinhold, New York.

An electron microprobe was used to study a suite of nine emerald samples representing four separate occurrences of gem-quality emeralds from northwestern Pakistan and neighboring Afghanistan. The study was undertaken to characterize the chemistry of the emeralds of the region, to compare the emeralds with emeralds from other locations, and to investigate local variations in composition. The results of the study could help unravel the complex and unusual parageneses of these deposits, and ultimately could aid in refinement of exploration techniques. The study also includes data for (1) green vanadian beryls from the Mohmand emerald district, (2) green chromium-rich tourmalines from the Swat emerald district, and (3) minerals in the carbonate host rock at Mingora. The electron microprobe technique allows nondestructive chemical analysis of discrete spots across a single crystal and is useful in the study of minerals.

This technique can determine transition metals responsible for color and can identify compositional zoning within single grains. The principal disadvantages of the technique are that elements lighter than fluorine (atomic number 9) cannot be determined and that different oxidation states of elements such as iron cannot be distinguished. Thus, we do not report data for beryllium, a major constituent of emerald; lithium and water, which can occur in emeralds in amounts up to several weight percent; and boron, a major constituent of tourmaline.

Key words: Mineralogy, Gemstone, Emerald, Mingora, Gilgit, Panjsher.

H/39. Hammarstrom, J.M., Snee, L.W. & Kazmi, A.H., 1988. Mineral chemistry of emeralds from N.W. Pakistan: Geologic setting, chemical signature, and zoning. Abstract with Programs, Geological Society of America 20, p.102.

Key words: Emerald, Mingora, Gilgit, Panjsher.

H/40. Hammer, V.M.F., 1999. Tiefgrüner lazulith. Lapis 24(5), 33-34.

Key words: Gemology, Lazulith.

H/41. Hamood, O., 1992-93. Tectonics and structure of Timargara-Lal Qila-Wari areas District Dir N.W.F.P. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 265p.

The structural geological mapping of 673 sq. km area of Timargara, Lal Qila and Wari areas District Dir N.W.F.P was conducted along with structural, petrographical economic geological studies. The area lies in the western extremity of Kohistan Island Arc where the Mesozoic amphibolitized ocean floor Kohistan Island arc are sutured to the Shamozai Green schist mélange which is under thrusted by gneisses of Indian plate.

The amphibolites exposed in the southern and northern extreme of the mapped area were the parts of a single ocean floor under which the arc was built. These amphibolites were formed by the metamorphism of basic volcanics and pillow lavas of tholeiitic affinities, and subordinate interlayered sediments of argillaceous, arenaceous and carbonate composition. The sediments were deposited on ocean floor along with lavas at mid oceanic ridge (MOR). The concentration of metasediments in the southern exposure is relatively less and thin as compare to northern part of amphibolite where thick piles of these sediments were evident. The amphibolites exposed in the project area are different from Kamila amphibolites which were formed by the metamorphism of basic plutonic rocks. The Kamila amphibolites represent the base of Kohistan Island Arc and are exposed near or, around Nangaparbat syntaxis due to uplifting and uncovering of base rocks. Whereas Dir amphibolites represent the supra crustal material of Kohistan Island Arc under which the arc was built. The southern part of Dir amphibolites are dominantly composed of fresh and altered plagioclase 20 to 38 % (altered to seracite, koalinite, epidote and chlorite) amphibolites hornblende 10 to 61 %, actinolite 15 to 15.5 %, tremolite 1 to 5 %, cummingtonite 1 to 6 % but in shear zones its amount is 17 to 30 %, and athophylitic 1 to 5 % and quartz 2 to 50 %. Carbonate metasedimentary layers with in these amphibolites contain calcite 10 to 25 % and siderite 18 %. Whereas biotite 18 % and garnet 6 % is found in meta argillaceous and arenaceous layers. The northern part of Dir amphibolites are mainly composed of fresh and altered plagioclase 3 to 47 % (altered to seracite, kaolinite, epidote and chlorite), amphibolites (dominantly hornblende 1 to 68 %, actinolite 2 to 52.5 % and quartz 3 to 65 %). The carbonate metasediments in these amphibolites contain 8 to 20 % calcite, whereas biotite is 0.52 to 31 % and garnet is 30 to 33 % (in two samples) in meta argillaceous and arenaceous part of these amphibolites.

From the geochemical studies of Dir amphibolites the major elements which were determined are SiO_2 (38.06 to 64.26 wt%), TiO_2 (0.07 to 1.3), Al_2O_3 (3.34 to 19.54), Fe_2O_3 (5.25 to 12.56), MnO (0.16 to 0.28), MgO (0.84 to 15.50), CaO (5.58 to 20.70), Na_2O (0.03 to 5.0), K_2O (0.17 to 1.44), P_2O_5 (0.01 to 0.20) and Cr_2O_3 (0.01 to 0.41 wt%). The trace elements are Ba (38 to 120 ppm), Ni (42 to 138), Sr (116 to 182), Zr (25 to 66), Y (12 to 20), Nb (10 to 24) and Sc (24 to 31 ppm).

The plutonic rocks exposed in the area consist of norite, gabbronorite, diorite, tonalite, trondhjemite, granite/adamellite and quartz porphyries/aplites/ pegmatites are intruded in the Dir amphibolites and were exposed due to uplifting and uncovering of amphibolites. But the presence of small and large roof pendant of amphibolite in these plutonic rocks (which previously called xenoliths and screens of amphibolites) evident the presence of amphibolites over there.

The petrographic studies of plutonic rocks show that there is gradational change in mineralogy from norite/gabbronorite towards diorite. The amount of quartz increases further from diorite (13.40%), tonalite (20%), trondhjemite (51.5%) to granite (54.1%) and adamellite (59.3%).

The amount of major elements determined from chemical analysis varies from norite/gabbronorite to acidic bodies as SiO_2 (52.78 to 70.54 wt%), Fe_2O_3 (9.62 to 1.53), MgO (6.08 to 0.59), CaO (8.06 to 2.7), Na_2O (3.11 to 3.340, and K_2O (0.51 to 3.82 wt%). Whereas TiO_2, Al_2O_3 Cr_2O_3 does not show any remarkable variation. MgO, Fe_2O, CaO and Al_2O_3 decreases with increase of SiO_2 towards tonalite and acidic bodies.

Generally three types of ultramafic rocks are exposed in the mapped area. The first type of ultramafic are highly altered and metamorphosed. These ultramafic rocks are present as exotic blocks in amphibolites. The second type which are present as roof pendant over the surface of some plutonic rocks (i.e. granite adamellite and diorite). These ultramafic were emplaced in oceanic crust (amphibolites) during its development at MOR. The third type of ultramafic which are mostly hornblendites and schelites are exposed both in amphibolites and plutonic rocks, were probably fractionated from the hydrous magma produced due to the partial melting of Indian plate and ascended to higher levels due to buoyancy acquired by their magmas as a result of residual liquid enrichment. Structural studies show that the rocks of Kohistan Island Arc exposed in the area are folded into northward dipping southward verging tight folds in the south (near MMT) which opens up northwards. The amphibolites have undergone at least two phases of isoclinal folding. In the first phase of recumbent or isoclinal folding S1 axial planner foliation was developed in these rocks. The first phase of deformation is probably related to the subduction of Kohistan Island Arc under Eurasian plate. In the second phase these rocks were again folded. The second phase is probably related to the subduction of Indian plate under Kohistan. The rocks of Kohistan Island Arc have undergone a third phase of deformation which produced in the shear zones and a retrograde metamorphism of chlorite grade along shear zone which is most probably related to the collision of Indian plate with Kohistan Island Arc.

The southern part of Dir amphibolites near MMT mostly trend EW and dips 65° to 80° northwards, which is almost parallel to the trend of MMT. In the central portion of the mapped area, the plutonic rocks trend NE to SW and their dip varies from 40° to 70° NW and SE most of the fold axes in plutonic sequence are parallel to each other which mostly trend NE to SW and plunges from 12° to 50°. The northern part of Dir amphibolites mostly trend NE and dips 15° to 60° SE.

The economic significance of rocks of the project area was also studied. Geotechnical properties of Balambat norite, Panjkora diorite and hornblendite were analyzed and found that these rocks could be used as dimension stones as well as aggregates and building material.

Key words: Tectonics, structure, Dir.

H/42. Haneef, M., Jan, M.Q. & Rabbi, F., 1986. Fracture fills or "sedimentary dykes" in the lake sediments of Jalala, NWFP. A preliminary report. Geological Bulletin, University of Peshawar 19, 151-156.

Quaternary lake sediments of Jalala in Mardan District are intersected by discordant structures which have been described as clastic dykes by Allen (1964). These sediments consist of horizontal, alternate beds of clay, silt and sand with local pockets of erratics. Poor sorting, angular to subangular shapes of the grains, and varied mineralogy indicate short distance of transport. Metasediments, amphibolite and granitoids are among the possible source rocks. Field evidences indicate that episodic tectonic activity produced fracture in the sediments which were filled by the plastic flow of clayey material from the overlying beds.

Key words: Lake Sediments, Quaternary, sedimentary dykes, Jalala, Mardan.

H/43. Hanif, M., 1980-82. Geology and Petrology of Sher Qila Gulapur, Bargu and Dalnati Area, Gilgit Agency. M.Sc. Thesis, Punjab University, Lahore, 84p.

Key words: Petrology, Gilgit.

H/44. Hanif, M., 1999-2000. Structure, stratigraphy and petrography of Aghar, Gulpur and Nar areas, District Kotli, Azad Jammu & Kashmir, Pakistan. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 134p.

The geological and the structural mapping of Aghar, Gulpur and Nar areas of about 200 square kilometers was carried on the scale 1: 50,000 using the Toposheet No.43 G/15 of Survey of Pakistan. Then it was enlarged to the present scale 1: 18750. The lithostratigraphic units exposed in the area are mainly sedimentary in nature and range in age from Upper Miocene to Pliocene. These units are the Nagri Formation (Upper Miocene) and the Dhok Pathan Formation (Pliocene) of Siwalik Group of rocks. The Siwaliks are the molasse sediments which were derived from the upthrusted mountain ranges of the Himalayas and adjoining foredeep area. The rocks of the area have been deformed during the two phases of deformation named as D1 and D2. D1 deformational event is related to F1 folds. F1 folds are the major anticlines and synclines of the area. These are Barali Anticline, Gulpur Syncline and Nar Anticline. F2 folds are formed during the second phase of deformation D2 due to change in plunge of F1 folds. About fifty rock samples were collected from different localities of the project area out of which twenty samples were selected for the petrographic studies. Tectonically, the Siwaliks lie in Sub-Himalayas and the project area is situated on the southern side of the Himalayan region, where the Siwaliks are deposited in the foreland basin. This foreland basin was formed in association with the collision of the Indian and Eurasian plates.
Key words: Structure, stratigraphy, petrography, Kotli, Azad Kashmir.

H/45. Hanif, S.M. & Khan, I.S., 1968. Petrology and structure of Khaki area, Hazara. M.Sc. Thesis, Punjab University, 75p.

Key words: Petrology, Structure, Mansehra.

H/46. Hanni, H.A., 1982. A contribution to the separability synthetic and natural emeralds. Journal of Gemmology 18, 138-144.

Gives chemical features of the two groups of emeralds. Two chemical analyses of emerald from Pakistan are also given.
Key words: Gemology, emerald, Swat.

H/47. Hansen, R., 1997. Remembering hazards as "Coping Strategy". Local perception of the disastrous snowfalls and rainfalls of September 1992 in Astor valley, Northwestern Himalayas. In: Stellrecht, I. & Winiger, M. (Eds.), Perpectives on History and Change in the Karakorum, Hindukush, and Himalaya. Culture Area Karakorum, Scientific Studies 3, 203-215. Rudiger Koppe, Koln.

Key words: Hazards, snowfall, rainfall, Astor valley, Himalaya.

H/48. Hanson, C.R., 1986. Bed rock geology of the Shigar valley area, Skardu, Northern Pakistan. M.S. Thesis, Dartmouth College, Hanover, New Hampshire, 124p.

For further details consult Hanson, 1989.
Key words: Geology, Shigar, Skardu.

H/49. Hanson, C.R., 1989. The northern suture in Shigar valley, Baltistan, northern Pakistan. In: Malinconico, L.L. & Lillie, R.J. (Eds.), Tectonics of the Western Himalaya. Geological Society of America, Special Paper 232, 203-216.

The Shigar Valley is crossed by a large, southwest-verging reverse fault containing pods of serpentinized ultramafic rock; the fault is correlated with the Northern Suture, which separates Paleozoic shelf-type sedimentary rocks of the Asian plate from Cretaceous volcanic rocks of the Ladakh-Kohistan arc. In the Shigar valley, the Asian plate is represented by a series of folded schists and marbles (the Daltumbore Formation) that is faulted southward over metasedimentary rocks and volcaniclastics (the Bauma-Harel Formation) belonging to the volcanic arc. Cretaceous turritellid gastropod fossils were found in the Bauma-Harel Formation. Metamorphism on both sides of the suture

occurred in a regime of high temperature but only low to moderate pressure. Metamorphic isograds are cut by the suture, so metamorphism must have occurred before faulting along the suture. Two main phases of igneous intrusion are exposed in the arc terrane: a pre-tectonic, possibly tholeiitic phase about 100 m.y. old, and a post-tectonic, calc-alkaline to subalkaline phase 40 to 60 m.y. old. The Northern Suture does not have the appearance of a major suture, but the Ladakh-Kohistan Arc seems to have been a separate plate from the Asian continent. The suture probably marks the closure of a small ocean basin in late Cretaceous to early Eocene time.
Key words: Tectonics, Northern Suture, Shigar, Baltistan.

H/50. Hanson, C.R. & Lyons, J.B., 1986. Bedrock geology of the Shigar Valley area, Skardu, Northeast Pakistan. Abstracts with Programs, Geological Society of America 18(6), p.627.

For further details consult Hanson, 1989 above.
Key words: Northern Suture, Shigar, Baltistan.

H/51. Haq, A. & Faruqi, F.A., 1962. Ceramic qualities of West Pakistan feldspar, quartz and talc. Proceedings, CENTO Symposium on Industrial Rocks and Minerals, Lahore, 142-147.

Key Words: Feldspar, quartz, clay, ceramics.

H/52. Haq, I., 1999. Geology and geochemical investigation of the part of Ushiri valley, Distt. Dir, Northern Pakistan. M.Phil. Thesis, University of Peshawar, 215p.

The study area is lying in the north-western portion of the Kohistan arc terrane. This terrane is bounded by two suture zones of regional extent at its northern and southern sides, believed to be formed by obliteration of ancient oceanic basin. The Kohistan arc consists of a series of east-west trending geological units, which are:
1) Jijal Ultramafic Complex, 2) Kamila A1nphibolite, 3) Chilas Complex, 4) Chalt Volcanic Group, 5) Yasin Group and 6) Kohistan Batholith. This arc experienced its first collision at its northern margin with the Karakorum plate at 90-80 Ma, and its second collision at the southern margin during Early Eocene with the Indian plate. Rocks of the area are distinguished into two main lithological units: (1) Amphibolites and (2) Metadiorites/Metagranodiorites. The amphibolites occupy the southern part of the studied area while metadiorite/ granodiorites are exposed in the northern part of the area. Both these rock units have intrusive contact and exhibit local faulting and shearing. The amphibolites also host small patches of gabbro-norites which are less metamorphosed. The amphibolites are generally massive but also exhibit banding at places. These amphibolites are intruded by quartz and quartzo-feldspathic veins especially in areas where the shearing and faulting are intense. The amphibolites are also intruded by the metadiorite/granodiorite in the form of small plugs. The metadiorites/granodiorites are medium to coarse-grained, massive in character and have xenoliths of amphibolites. Copper mineralization in the form of dissiminated grains of tetrahydrite and chalcopyrite and supergene enrichened in the form of melachite and azurite occur within quartz veins in limited areas. Petrographically the amphibolites are mainly composed of hornblende and plagioclase with subordinate amount of quartz and alkali feldspar. Biotite, muscovite, chlorite, epidote, apatite, sphene, rutile, calcite and opaque occur as accessories. The metagabbro-norites contain plagioclase, orthopyroxene and clinopyroxene, as the dominant mineral constituents. Quartz, sphene, apatite, chlorite, epidote and opaque are present as minor constituents. The metadiorite, quartz-diorite and metagranodiorite are dominantly composed of plagioclase with variable proportion of quartz and alkali feldspar. The other minor constituents include biotite, hornblende, muscovite, apatite, sphene, zircon, garnet and opaque. Chemically the amphibolites and metagabbro-norites are comagmatic. Their chemical characteristics favour the igneous parentage (i.e., host gabbro-norite) for the studied amphibolites. Both the amphibolites and gabbro-norites could be related to either Kamila amphibolites belt or Chilas Complex. The major and trace elements study of these rocks suggests that these are of calc-alkaline nature and are formed by the arc magma within the subduction related environment. The chemical characteristics of the granitoid rocks (metadiorite/granodiorite) suggest that these are comagmatic and have close affinity towards the calc-alkaline rocks, developed in island arc type of set up. The mineralogical and geochemical studies of the stream sediments (both pan concentrate and -80 mesh) suggest that the area has no anomalous zone of base and precious metals which could be attributed to the specific mineralization in the area.
Key Words: Petrography, mineralization, base metals, Kohistan arc, Dir.

H/53. Haq, I. & Nowshervi, A.R., 1966? Chemical studies of iron ores of North western region of Pakistan. Pakistan Journal of Scientific and Industrial Research 18 (2&3)?, 106-108.

Key Words: Chemistry, mineral deposits, Iron ore.

H/54. Haq, M.F., 1962. Mineral development in Pakistan. Natural Resources 1 (3), 43-46.

Key Words: Chemistry, Iron ore.

H/55. Haq, S.S.B. & Davies, D.M., 1997. Oblique convergence and lobate mountain belts of western Pakistan. Geology 25, 23-26.

The thin-skinned structures of the Pakistani convergent margin have formed as a consequence of the relative motion between India and Eurasia. Most of the resultant motion is being accommodated along or near the current edge of the Eurasian plate: the southwest-northeast striking Chaman fault zone. It has been observed at oblique margins that the total plate motion is resolved into a component parallel to the margin, accommodated through strike-slip faulting, and a component normal to the margin taken up as contraction. However, the orientations of structures along the Pakistani convergent margin in and around the Sulaiman lobe and Sulaiman Range cannot be explained simply by resolving the plate motion vector into components normal and parallel to the plate boundary. Our modeling suggests that the complex juxtaposition of strike-slip faults with thrust faults of various orientations can be explained by the presence of a block centered upon the Katawaz basin that translates along the southwest-northeast structural barrier of the Chaman fault zone, moving with respect to both Eurasia and India. As this relatively rigid block moves northeastward relative to Asia, it causes deformation of the sedimentary cover and is responsible for much of the structural complexity in the Pakistani foreland. Our simple model explains several first-order features of this oblique margin, such as the eastward-facing Sulaiman Range, the strike-slip Kingri fault (located between the Sulaiman lobe and Sulaiman Range), and the reentrant at Sibi. This leads us to conclude that very complex structural and geometric relationships at oblique convergent plate boundaries can result from the accommodation of strain with simple initial geometric constraints.
Key Words: Tectonics, structure.

H/56. Haq, Z., 1990-91. Geology and petrography of Kundal Shahi, Thunian, Thod and Balkand area Neelum valley, District Muzaffarabad (A.K.). M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 92p.

The Project area is located in district Muzaffarabad (A.K), it covers about 200 Sq. Km the part of topographic sheet-No. 43 F/I3 and 43 F /14 published by survey of Pakistan.
Geologica1 map at a scale 1:15000 from Kundal Shahi to Balkand area is presented. The area includes Salkhala Formation/Tanol Formation. On the basis of field observation and Petrographic studies the rock units are interpreted accordingly. The rock units exposed are the metasediments of the Precambrian age with sheet intrusives. These intrusives are from granite to pegmatitic in nature and composition, pelitic to psammitic and furthermore calc silicates are also present in the northern side of area. The metasediments are under normally prograde metamorphism towards north. While some effects of retrogressive metamorphism are also observed. The mineral assemblage lies from green schist to lower amphibolite facies.
Key Words: Geology, petrography, Neelum valley, Azad Kashmir.

H/57. Haque, A.F.M.M., 1956. Shorter contributions to the geology of Pakistan. Geological Survey of Pakistan, Record 8 (2), 60p.

Key Words: Geology, Pakistan.

H/58. Haque, A.F.M.M., 1962. Some Upper Cretaceous smaller foraminifera from West Pakistan. Geological Survey of Pakistan, Memoir 2(3).

Key Words: Cretaceous, Paleontology, foraminifera.

H/59. Haque, A.F.M.M., Ivanac, J.E., Traves, D.M. & King, D., 1956. The geology of the NW portion of the Gilgit Agency. Geological Survey of Pakistan Records, 8(2), (Containing 6 Rep.).

For further details consult Ivanac et al., 1954.
Key Words: Geology, Gilgit.

H/60. Haque, A.F.M.M. & Wood, A., 1956. The genus *Cyclodooulina* (foraminifera) with a description of the new species from Pakistan. Geological Survey of Pakistan, Records 8(2).

Key Words: Paleontology, foraminifera.

H/61. Haque, S.M., 1974. Geology of the Balambat quadrangle (Toposheet No. 38 N/13), District, Dir, West Pakistan. Geological Survey of Pakistan. Information Release No. 81, 34p.

The Balambat quadrangle (38 N/13) covers about 250 square miles of mountainous terrain in Dir state in the north western part of West Pakistan.
The quadrangle is underlain by metamorphic and igneous rocks, comprising four main rock types, i) quartz-fledspar-biotite schist with interlayers of metamorphosed limestone, ii) amphibolite, iii) rocks of diorite group and iv) series of pegmatite-aplite dykes cutting the amphibolite and the diorite group rocks.
The amphibolite is well foliated and has quartzite and gneissic interlayers and inclusions of granitic rocks. It is conformable and gradational with the quartz-feldspar-biotite schists. The diorite group of rocks intrusive into the amphibolite consists of varieties of diorite and granodiorite and hornblendite. Bulk of this group has been metamorphosed. The amphibolite has been folded into a major syncline trending east-northeast. Foliation and mineral lineation form very characteristic structural features of the rocks. Foliation is well developed in the schist and the amphibolite, and weakly developed in the diorite.
Few folds, observed, are small and partially exposed. They are similar folds moderately open to tightly appressed and appear to belong to a single fold system. Microfolds and ptygmatic folds, which commonly characterize the amphibolite, have presumably resulted from the effect of metamorphic flowage. Very few faults have been observed. They are in part parallel with foliation, which are shear faults, and in part transverse to the foliation.
A structural analysis by plotting the recorded foliation, and lineation has been attempted. The results in general confirm the field observation and lead to the following conclusion.

1. The quadrangle area is occupied by a large syncline trending ENE-WSW.
2. The preexisting structure has not been substantially affected by particular deformation producing
3. In a large part the folds are more or less isoclinal
4. In part of the area the folds are reclined type.

Showings of pyrite chalcopyrite and bornite? As dissiminated in quartz-feldspar dykes and at a place beryl in a pegmatite dyke were noted. Small occurrences of kaoline resulting from weathering of feldspar rich portions of pegmatite are common in some parts. No pattern of mineralization could be established.
Key Words: Geology, Balambat.

H/62. Harding, R.R. & Wall, F., 1987. Blue spinel from Hunza valley, Pakistan. Journal of Gemmology 20, 403-405.

The spectral features of the blue spinel from Hunza valley are described. The crystals occur as single or twinned octahedral. The mean of nine probe analyses is SiO2 0.05, TiO2 0.18, Al_2O_3 69.3, Cr_2O_3 0.73, V_2O_3 0.05, FeO 3.75, MnO <0.05, MgO 24.6, ZnO 0.35, CaO < 0.05, NiO < 0.05, = 99.01. The presence of Ti and Cr in addition to Fe is probably responsible for the colour.

Key Words: Gemstones, spinels, Hunza.

H/63. Hartmann, H., Hepp, G. & Luft, U., 1941. Physiologische beobachtungen am Nanga Parbat 1937/1938. Luftfahrtmedizin 6, 1-48.

Key Words: Geography, Nanga Parbat, Himalaya.

H/64. Hasan, B., 1962. Utilization and exploration of indigenous constructions material by WAPDA, West Pakistan. CENTO Symposium on Industrial Rocks and Minerals, Lahore, 375-389.

Key Words: Construction material, WAPDA.

H/65. Hasan, B., 1987. Surface water storages in mountainous regions of Pakistan. In: Shams, F.A. & Khan, K. (Eds.), Resources Potential of Mountainous Regions of Pakistan. Centre for Integrated Mountain Research, Punjab University, Lahore, 60-65.

Key Words: Hydrogeology, Pakistan.

H/66. Hasan, B. & Khan, S.A., 1986. Possible impact of plate tectonics on Basha Dam Site. Abstracts, Symposium/Workshop on Plate Tectonics and Crust of Pakistan. Institute of Geology, Punjab University, Lahore, 26-27.

The Basha Damsite is proposed on the Indus River 314 km upstream of Tarbela and 40 km downstream of the town of Chilas. It will be a 660 feet (200m) high Dam, constructed of earth and rock with a central core and concrete cut off to bedrock. It will store 7.3 MAF (9.3 km3) of water and would generate 2400 MW of power. Rocks exposed at site are predominantly igneous complex, comprised mostly of Norite with subordinate Peridotite and Hornblendite.
The Main Mantle Thrust, which forms the Northern boundary of Indian Plate, is located at a distance of about 30 Km to the south of Basha Dam Site and dips towards Basha. The Northern Megashear passes East to West at the Southern boundary of Eurasian plate. The plate tectonics and associated structures could possibly affect the design of the dam seriously. In the present state of the art the seismic factors are evaluated for maximum credible earthquake (MCE) and operation basis earthquake (OBE). The structure which could create great hazards to human life on their failure are designed on the MCE, while others are designed for OBE. For this purpose it is pertinent to evaluate all the major fault of the area including the plate tectonics.
The Indus river occupies a broad valley between Raikot and the damsite which is filled with sediments upto a considerable depth. Faults could also be present under the alluvium, Raikot fault on which several hot springs are present, is located in the upstream area of the reservoir. The Raikot fault and possible burned faults could get activated under Basha reservoir water load and seepage water penetrating into the fault planes and induce higher siesmicity.
Any storage project on the main stem of Indus cannot be constructed unless all the aspects having bearing on the safety of the dam are evaluated. For this purpose it has to be ascertained that no major event of catastrophic nature will occur during the life of the project or if so, correct provisions are made in the design. The paper details broadly the possible effect of the plate tectonics and associated geologic features on the proposed dam-site.
Key Words: Plate tectonics, structural geology, Bhasha dam, MMT.

H/67. Hasan, M.T., 1986. Proterozoic and Cambrian phosphorites deposits: Hazara, Pakistan. In: Cook, P.J. & Shergold, J.J. (Eds.), Phosphate Deposits of the World 1, 190-201.

Marine phosphorite deposits of Cambrian age are located in the NW of Pakistan on the flanks of the structurally complex Hazara-Kashmir syntaxis. Phosphorite deposits are developed at two horizons within the bedded cherty dolomite of the Abbottabad formation and a horizon within the shale and siltstone of the overlying Hazira formation.

The phosphorite is partly siliceous, generally granular, but also dense and laminated, and dark in colour. The Phosphate content ranges 10-30% P"SUB 5" and reserves of phosphate rock are estimated at 22.9 million tones. The deposits will be difficult to mine because of extensive faulting and folding.
Key words: Cambrian, phosphorite, Hazara.

H/68. Hasan M.T., 1989. Cambrian phosphorite deposits of the Hazara Division, North West Frontier Province, Pakistan. In: Notholt, A.J.G., Sheldon, R.P. & Davidson, D.F. (Eds.), Phosphate Deposits of the World: Volume 2, Phosphate Rock Resources. Cambridge University Press, 449-454.

For further details consult the preceding account.
Key words: Cambrian, phosphorite, Hazara.

H/69. Hasan, M.T. & Aslam, M., 1974. Reconnaissance geology of the Indus valley road, Pakistan. Geological Survey of Pakistan. Information Release 78, 8p.

This is a broad description of the Karakoram Highway. The road passes through the northern part of the Indian plate, followed northward by mafic to granitic rocks (now termed the Kohistan arc), and then sedimentary rocks and granites of the Karakoram plate.
Key words: Reconnaissance, geology, Indus Valley road.

H/70. Hasan, M.T. & Asrarullah, 1989. Phosphate (apatite) resources in the Loi Shilman carbonatite, Khyber Agency, North West Frontier Province, Pakistan. In: Notholt, A.J.G., Sheldon, R.P. & Davidson, D.F., (Eds.), Phosphate Deposits of the World: Volume 2, Phosphate Rock Resources. Cambridge University Press, 455-457.

This paper deals with some of the carbonatite body at Loe Shilman. This carbonatite body contains large amounts of apatite.
Key words: Economic geology, apatite, carbonatite, Loe Shilman.

H/71. Hasan, M.T. & Ghaznavi, M.I., 1980. Phosphate deposits of Hazara Division, North West Frontier Province, Pakistan. Geological Survey of Pakistan , Records 50, 1-18

Key words: Phosphate, Hazara.

H/72. Hasan, M.T. & Ghaznavi, M.I., 1995. An over view of Hazara phosphate deposits, NWFP, Pakistan. Abstracts, International Symposium and Field Workshop on Phosphate and Other Industrial Minerals, Abbottabad, p.31.

Key words: Phosphate, Hazara.

H/73. Hasan, M.T., Ghaznavi, M.I., Karim, T. & Turi, A.A., 1991. Phosphorite deposits of Barkot, Sherwan area, Abbottabad, Hazara Division. Geological Survey of Pakistan, Misc. 6, 12p.

The investigated area lies in the toposheet No.43 F/4, 30 km west of Abbottabad town. The work was undertaken for studying and firming up the phosphorite deposits in the area. Phosphorite is developed in the basal beds of Hazira and upper most part of Abbottabad Formation. The lateral extension of phosphorite is about 750 meters with a variable thickness of 2-3 meters. The total probable reserves of low to medium grade are estimated atO"4050 million metric tonnes with P_20_5 ranging from 7 to 25 percent.

Key words: Phosphorite, Abbottabad.

H/74. Haserodt, K., 1982. The Quaternary glaciation of the Pakistan Hindukush (Chitral). Sitzungsbericht u. Mitteilungen der Braunschweiger Wissenschaftlichen Gesellschaft, Sonderband 6.

Key Words: Glaciation, Hindukush.

H/75. Haserodt, K., 1984. Aspects of present climatic conditions and historic fluctuation of glacier in Western Karakorum. In: International Conference on Karakorum Culture, Gilgit 1983.

Key Words: Climate, glaciology, western Karakoram.

H/76. Haserodt, K., 1989a. Chitral (Pakistanischer Hindukusch). Strukturen, wandel und probleme eines lebensraumes im Hochgebirge Zwischen gletschern und wuste. In: Haserodt, K. (Ed.), Hochgebirgsraume nord-Pakistans im Hindukusch, Karakorum und Westhimalaya. Beitrage und Materialien zur Regionalen Geographie 2, 43-180.

Key Words: Structure, glaciers, Chitral.

H/77. Haserodt, K., 1989b. Zur pleistozanen und postglazialen vergletscherung zwischen Hindukusch, Karakorum und Westhimalaya. In: Haserodt, K. (Ed.), Hochgebirgsraume nord-Pakistans im Hindukusch, Karakorum und Westhimalaya. Beitrage und Materialien zur Regionalen Geographie 2, 181-233.

Key Words: Glaciation, Pleistocene, Hindukush, Karakoram, Himalaya.

H/78. Haserodt, K., 1994. LawinenfuBgruben und lawinenfuBschuttwalle im oberen Kaghan-Tal (Westhimalaya, Pakistan). In: Haserodt, K. (Ed.), Physisch-Geographische Bitrage zu hochgebirgsraumen Nordpakistans und der Alpin. Beitrage und Materialien zur Regionalen Geographie 7, 115-127.

Key Words: Kaghan valley, Himalaya.

H/79. Haserodt, K., 1995. Change of climate in the Hindukush region – facts, trends and necessary observations of the environment. IIIrd international Hindukush conference, Chitral, Pakistan. 20p.

This is a detailed report on climate change in Chitral and adjuscent areas, supported by many figures. Data for mean annual precipitation of Drosh, Chitral, Gilgit and other places for 1965 – 1982 is given. Graphical presentations of mean air temperature and of the amount of river discharge at Chitral town are also given.
Key Words: Climate change, environment, Chitral.

H/80. Haserodt, K., 1996. The geographical features and problems of Chitral: A short introduction. In: Bashir, E. & Israr-ud-Din (Eds.), Proceedings of the Second International Hindukush Cultural Conference, September 19-23, 1990, Chitral, 3-18. Oxford University Press, Karachi.

Key Words: Geography, Chitral.

H/81. Hashmat, Z., 1970-72. Geology of Manarai Band area (Upper Swat). Institute of Geology, Punjab University, Lahore, M.Sc. Thesis, 57p.

Rocks of Manarai Banda area comprise metamorphic rocks making buttress of Himalayas. They are known to extend to form Dir and extend to Kalam.

Three different rock types are exposed within 50 miles2 of area mapped.

Amphibolites have been metamorphosed to amphibolite grade; hornblende, epidote and in some garnet are very common. The group has a thrust faulted contact with the rocks of lower Swat-Buner schistose group. Ultramafic body is formed by the complete alteration of Peridotite bodies occurring in the surrounding area. The area is of some economic importance because of the occurrence of magnetite and corundum.

Key Words: Petrology, metamorphic rocks, ultramafics, Swat, Himalaya.

H/82. Hashmi, F.A.S., Khan, S.A. & Haq, I., 1984a. Geology, geotechnique and construction of Khanpur dam project. Abstract, First Pakistan Geological Congress, Lahore, 9-11.

Key Words: Geotechnical, dams, Khanpur.

H/83. Hashmi, F.A.S., Khan, S.A. & Haq, I., 1984b. Geology, geotechnique and construction of Simly Dam Project. Abstracts, First Pakistan Geological Congress, Lahore, 13-14.

Key Words: Geotechnics, dams, Simly dam.

H/84. Hashmi, M.A., 1982-84. Geotechnical studies of land slides along Karakoram Highway; from Batgram to Thakot, District Mansehra. M.Sc. Thesis, Punjab University, Lahore, 90p.

Key Words: Geotechnical, landslides, KKH, Batgram, Thakot, Mansehra.

H/85. Hassan, B., 1984. Geo-technical problems for Kohala tunnelling. Abstracts, First Geological Congress, Lahore, 40-42.

The Jhelum River runs in a gorge throughout its journey in Azad Kashmir territory. It flows in North/Westerly direction while entering the area and follows the same direction upto Domel where it takes a very sharp turn to the South and continues in rapids towards Mangla where it debouches into the plains. Enroute it is joined by the waters of the Neelum and Kunhar. The river, in the upper arm of bend has a steep gradient of about 31 feet per mile which flattens to 13 feet per mile along its lower reach. Depending upon the respective locations on either side of the syntaxial bend a drop of 200 feet to 950 feet can be created and utilized for power generation, by linking both arms through 2 miles to 11 miles long transmountain tunnels.

As a result of preliminary design studies, four different alignments for topographic survey and geological investigations work were picked up. Further studies and field investigations narrowed to the most attractive choice for Barrage and Tunnel alignment near Dhani Village.

The scheme recently investigated envisages a low height diversion dam of 72 feet, about 9 miles Upstream of Muzaffarabad. The water would be diverted through two six mile long 24 feet finished diameter tunnels outfalling into Jhelum river, 13 miles downstream of Muzaffarabad. Natural drop of above 570 feet would thus be available and utilized to install 500 MW capacity. The project configuration also offers the possibility of integration with the upstream Neelum/Jhelum, diversion hydel project, which would substantially increase its power potential.

Regional Geological Framework

The project area occupies the axial zone of the "North Western Syntaxis". River Jhelum also takes almost 90^{O} turn at Muzaffarabad shown by the change in its course from westerly direction upstream of Muzaffarabad to the south (downstream of Muzaffarabad). There are two more or less parallel thrust faults that warp around the syntaxis. These have been named as Punjab thrust and the Jhelum/ Murree faults. The syntaxis contains the youngest rocks i.e. Murree formation in its core, successively older rock warp around the periphery. South of Muzaffarabad the Jhelum/Murree fault, passes at a short distance from Kohala power house area but has a steep dip (70º – 80º) towards east. The fault strikes N 30-50ºEast. The area lying within the sharp bend of river Jhelum is a big synclinal structure with an anticlinal structure within it. This highly complex geology might have considerable influence on various engineering structures, particularly in the power tunnels area.

Geological Features along Tunnels Alignment; About 6 mile long, two tunnels are proposed for Kohala power generation. It is very difficult and expensive/to do any sub-surface investigations in these tunnel alignments due to high relief and rough terrain. Hence only strip surface geological mapping has been conducted. It is difficult to project the geology at the tunnel level from the strip surface geological maps due to complex geology of the area. On the basis of the strip and regional geological mapping, it is interpreted that the major rock units of sandstone and shale will be encountered during the excavation of the tunnels. The physical & structural characteristics of sandstone and shale along tunnels have been inferred from the extensive drilling done, on nearby other projects in Murree formation. Number of adits have been done on similar rock units at Abassian Dam site. A number of rock mechanical in situ tests were also conducted in the adits, which would help in evaluating the design parameters for the proposed tunnels. However, it is very difficult to assess the proportion of the sandstone and shale which shall be encountered and its structural characteristics along the tunnel alignment. The study of aerial photographs and surface geological feature, it has been evaluated that tunnel alignment area is highly folded and faulted. Due to tight folding and faulting, it is difficult to predict the geological features of the area at tunnel elevation. Due to high rainfall, Snow cover in part of that area and the geological structure acute ground water problem is expected during tunnel excavation.

Anticipated Geological Problems

It is anticipated that foundation rock, particularly the sandstone shall be highly jointed and fractured due to tight folding in the area. Proper precaution and controlled blasting would have to be undertaken to reduce the excessive breakage during the excavation particularly in the jointed sandstone. It may also be necessary that the shale whenever excavated be immediately provided with supported and protective cover to protect against surface weathering. Acute ground water problem may be encountered during the excavation of the tunnel. As sandstone has interbeds of shale, the tunnel inlet and outlet areas should be excavated with care to avoid any possible slips along the weaker planes. The above problems will be explained during presentation of the paper with the help of maps/charts/photographs to elicit useful discussions.

Key Words: Engineering geology, Jehlum River, Kohala, Azad Kashmir.

H/86. Hassan, C.S., 1981-83. Geology and Petrology of Lower Yasin Valley Gilgit Agency. M.Sc. Thesis, Punjab University, Lahore, 85p.

This field report described the results of geological studies in area, extending Sher Qila to Gahkuch, in Lower Yasin Valley, Gilgit Agency. The enlargement from toposheet was prepared. On this map different units are shown as granite, diorite, amphibolite and paragneiss. The mineralogical description and petrographic analysis of these rock units are reported in detail. The petrogenesis of these rock units has been discussed as well.

The granite is considered to be a part of Karakoram axial granite, which is emplaced as partially fused and mobile mass rich in alkali feldspar during synthetic phase of orogeny. The diorite is probably tholeiitic basaltic magma injected into the pre-existing rocks, which were partially melted and assimilated. Decrease of calcic contents produced granodiorite during cooling. Green stone is product of regional metamorphism of basic igneous rocks.

Intense tectonic disturbance is evident from the frequent occurrences of strained and crushing effect on minerals. The area shows evidence of extensive mountain glaciation in the quaternary and glacial deposits are common. The economic mineral potential of the area is also discussed.

Key Words: Petrology, petrography, granites, diorites, Yasin valley, Gilgit.

H/87. Hassan, M., 1977. Oil and gas prospects of the basins of Pakistan. Geological Bulletin, Punjab University 14, 91-94.

The history of petroleum investigations in Pakistan is very old and can be traced back to the middle of 19th century. However, oil in commercial quantities was found in 1914 at Khaur, by the Attock oil company. Since then, several companies have carried out extensive survey of the ·country and exhaustive information on petroleum ·geology has been accumulated, though most of ·this work is not open to the public. Some of the works available are those of

Rahman (1963), Movshovitch (1968) Sokolov (1971) and others. Classification of areas of Pakistan into oil and gas and possible oil and gas basins has been worked out by these authors. Before proceeding further it will be plausible to understand the term "basin" and the sense in which it is being used in the present work. Olenin (1977) defines oil and gas basin as a geological body within the limits of a large element of the stratisphere which is structurally immersed as a whole relative to its limiting elements. Thickness, form and composition of the sediments forming this body and its hydrogeological characteristics guarantee in its generation and accumulating of dispersed hydrocarbons and conservation of pools of oil and gas.
Key Words: Hydrocarbon, oil, Pakistan.

H/88. Hassan, M., 1996. Late-Quaternary terrace sequence in the piedmont zone, tectonics and palaeoclimatics in Peshawar vale, Pakistan. Programme and Abstracts, 8th All Pakistan Geographic Conference, Peshawar, p.20.

Key Words: Quaternary deposits, Paleoclimate, Peshawar.

H/89. Hassan, M., 1997. Little Ice Age in Pakistan. Abstracts, 9th All Pakistan Geographic Conference, Islamabad, 16-17.

Key Words: Glaciation, ice age.

H/90. Hassan, S., 1990-92. Geological mapping and evaluation of geotechnical and deformability, characteristics of building materials, Neelum valley, Azad Kashmir. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 62p.

Granitic gneisses, schists, Hazara slates, dolomite, marble, Panjal volcanics, Margalla Hill limestone exposed in various parts of Nee1um valley Azad Kashmir have been investigated for geotechnica1 properties, chemical and petrographic characters to evaluate these rocks as building material. The physical properties like compressive strength, crushing strength, soundness, absorption, porosity and specific gravity observed in the rock samples of various localities have been found within the range of ASTM specification with few exceptions.
A modified classification has also been proposed on the basis of porosity and absorption percentages. Various grades of building materials have been made for economic exploitation of the rocks taking into consideration the accessibility, cheap labour and geographical control of the area. It is suggested that the marbles are presently being used as roadstone is not rational. The Panjal volcanics are still to be investigated as building material or roadstones, the gneisses are good decorative stones. The dolomites can be rationally exploited for steel manufacture. The rational use of limestones is in cement industry.
Key Words: Mapping, building material, Neelum valley, Azad Kashmir.

H/91. Hattori, K. & Shirahase, T., 1998. Platinum group element signatures of ultramafic-mafic rocks of the Kohistan block: evidence for crustal cumulate origin. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop, 76-77.

The Kohistan block in northern Pakistan near the India-China border is bounded by the Main Karakoram Thrust to the Eurasian continent and by the Main Mantle Thrust to the Indian continent, The east-trending, crescent-shaped block is interpreted to be a 100 Ma island arc within the Tethys ocean, which was accreted and uplifted during the Himalayan orogeny. The block consists of four units; ultramafic Jijal complex, Kamila amphibolite, gabbroic Chilas complex and volcanic rocks of Chalt complex in ascending order to the north. The Chalt complex is predominantly basaltic-andesitic volcanic rocks with intercalated sedimentary rocks. The Chilas complex consists of gabbro, gabbronorite, norite and minor troctolite and dunite. The igneous rocks in the complexes show low concentrations of high field strength elements (HFSE) compared to large ion lithophile elements (LILE) indicating arc origin [1]. High εNd (100 Ma; +5 to +6) and mildly low initial 87Sr/86Sr ($\approx$ 0.70400 at 100 Ma; [2]) suggest derivation from a depleted mantle wedge. The Jijal complex consists of dunite, pyroxenite and websterite. The lithology and the relationship with other units have suggested an origin as cumulates of arc magmas. However, there has been no geochemical evidence to, support this interpretation because the incompatible elements that might have been useful for petrogenic study have low contents in the ultramafic rocks. Also, alteration-metamorphism may have modified their trace element compositions. Thus the usual geochemical tools are not likely to be useful for identifying the origin of the ultramafic rocks. Ultramafic rocks, however, contain significant concentrations of platinum group elements (PGE; ruthenium, palladium, osmium, iridium, platinum, rhodium), which are diagnostic for the origins of the rocks.

Here, we report the concentrations of Re and PGE for the ultramafic and mafic rocks from the Kohistan block.

The concentration of PGE in Kohistan rocks are highly fractionated with low Os, Ru and lr and high Pt, Pd and Re. Gabbroic rocks contain very low lr-type PGE (Ir, Ru, and Os): less than 10 ppt Os and 50 ppt lr. Even ultramafic rocks of the Jijal complex with high MgO (<30 wt.%) and Ni (<800 ppm) contain low Os (<0. 13 ppb), lr (<0. 79 ppb) and Ru (<0. 9 ppb). They are much lower than mantle rocks, which contain ~ 4 ppb Os, ~ 3 ppb Ir, and ~ 5 ppb Ru. The patterns of PGE, which are normalized to primitive mantle composition, show a deep concave shape: moderately high Ni, deep lows at Os, lr and Ru and steep positive slope towards Pt (<0.5 times PM), Pd (<3 times PM) and Re. The total PGE contents show a broad correlation with the concentrations of Sr. Because Sr is an incompatible lithophile element, the correlation with siderophile and chalcophile PGE indicates a low sulphur concentration in the parental magmas. The results indicate that the ultramafic rocks in the Kohistan block are indeed cumulates of arc magmas, which formed by partial melting of a depleted mantle, under sulphur-unsaturated condition, The parental magmas did not reach sulphur saturation during cumulate crystallization- The PGE concentrations and patterns from the Kohistan ultramafic rocks are identical to websterite and dunite from the cumulates of the Jurassic Talkeetna arc in Southern Alaska [3]. Similar patterns of PGE and covariation with other lithophile elements from the two arcs appear to suggest that arc magmas are generally sulphur unsaturated during the partial melting in the mantle source and during crystallization in the lower crust.

To evaluate the Os isotope ratios of the arc magma, 187Os/186Os ratios were determined. They range from 1.19 to 1.55 (187Os/186Os =0.143-0.187). The values are low, although higher than the depleted mantle value, 187Os/186Os = ~l (187Os/186Os = ~ 0.120). Although the precise initial ratios are difficult to determine due to probable mobility of Re, the date suggest that the subduction-related mantle metasomatism was accompanied by little enrichement of radiogenic Os.

Key Words: Ultramafics, PGE, MKT, Himalaya.

H/92. Hayase, I., 1965. Age determination of a Karakorum rock. In: Matsushita, S & Huzita, K. (eds.,), Geology of the Karakoram and Hindukush. Results of the Kyoto University Scientific Expedition to the Karakoram and Hindukush, 1955, Vol. VII, 149-150. Nippon Printing & Publishing Co., Ltd., Japan.

In Dusso area, granitic pegmatites commonly intrude granitic gneisses. This is a study of age determination on the whole rock sample of a pegmatite by Rb/Sr method and on its muscovite by K/Ar method. The Rb/Sr date is distinctly older (28 Ma) than the K/R date (4 Ma).

Key words: Geochronology, pegmatite, Dusso, Nanga Parbat.

H/93. Hayat, A.M.S., 1968. Geology of Balakot and Dadar Area. M.Sc. Thesis, Punjab University, Lahore, 83p.

An attempt has been made to map the area in detail and as such, apart from drawing isogrades in different metamorphic units, their grades and types of' metamorphism have been studied thoroughly. Contacts have been traced, followed and plotted in the case of the sedimentaries and their environmental -conditions, correlation and age have been discussed and, structure pointed out. Granite, which occupies about one third of the area concerned, has been assigned a magmatic origin, due to certain definite field evidences (explained under granite). Great emphasis have been placed structure, as the area lies at the tip of the Syntaxial bend, one of the greatest controversies of all times (Geological). Five stereographic projections have been provided in order to show the types of stresses prevailing in the area, clarified further by the two geological sections attached to the map and a special structural map included. Fifty thin sections have been studied under microscope, of which thirteen have been included in the report. Four faunas have also been described.

Key Words: Geology, Balakot, Mansehra.

H/94. Hayat, M.N., Afridi, G.S., Tariq, M. & Faqir, G., 1977. Geology of southwest of Kotal Post, Kohat, N.W.F.P. M.Sc. Thesis, University of Peshawar, 105p.

Key Words: Geology, Kohat

H/95. Hayden, H.H., 1896. On some igneous rocks from the Tochi valley. Records of the Geological Survey of India 29(3), 63-69.

Key Words: Igneous rocks, Tochi valley.

H/96. Hayden, H.H., 1898. On the geology of Tirah and the Bazar Valley. Geological Survey of India, Memoirs 28(1), 96-117.

This is paper is compiled from notes made by me while attached to the Tirah Expeditionary Force, during the months of October to December, 1897. The area examined consists of parts of the country lying between the Samana range and the southern slopes of the Area examined portions of Khaibar) Chura and the Bazar Valley. Of this area, the geology was in part known from the survey made by Mr. Griesbach1 in Previous observers.1891, yet there still remained a considerable portion the geology of which could only be conjectured, and although the nature of the late expedition was such as to preclude the possibility of an exhaustive examination of the still unmapped country, yet-the route followed by the troops crossing the strike of the strata at right angles-opportunity was afforded for an examination of almost the entire sequence of beds between the Samana range and the southern slopes of the Safed Koh. I propose to divide this paper into two sections: the first dealing with the country south of the Safed Koh and its eastern extension, the Surghar range, and the second dealing with the area lying north of those ranges. I.--The Area South of the Safed Koh. Orographically this area consists of four main mountain ranges parallel to one another and running almost due Orography. These ranges are separated by longitudinal troughs, but locally connected with one another by spurs trend 1 Vide his paper on “The Geology of the Safed Koh." Rec. G. S. I., Vol. XXV, p. 59. In the same paper will be found a list of the most important literature bearing on the subject.
Key Words: Geology, Tirah valley.

H/97. Hayden, H.H., 1907. Notes on certain glaciers in Northwest Kashmir. Geological Survey of India Records, 35, 127–137.

Key Words: Glaciers, Kashmir.

H/98. Hayden, H.H., 1910. The Hasanabad glacier in Hunza. Geological Survey of India Records. 40(4), 339–340.

Key Words: Glaciers, Hasanabad, Hunza.

H/99. Hayden, H.H., 1914. Notes on the geology of Chitral. Records geological Survey of India, 65, P.271-.

Hayden made the first important geological traverse through northern Pakistan. He followed the rout through Chitral, over darkot pass, down the Yasin valley, east to Gilgit, then north along the Hunza River valley. This traverse, though hurried, gave two cross-sections approximately noral to the regional trend. His notes contain valuable descriptions and correlation including those of the darkot group, Chalt volcanics, Yasin group, and the granitic batholiths.
Key words: Stratigraphy, geology, Hindukush, Karakoram, Kohistan.

H/100. Hayden, H.H., 1916. Notes on the geology of Chitral, Gilgit and the Pamirs. Geological Survey of India, Records 45(4), 271-335.

Hayden performed reconnaissance survey of the area from Mastuj, via Darkot, Yasin, Gupis, Gilgit, Hunza onward, to Pamir. The traverse, though hurried, gave two cross-sections approximately normal to the regional trend. He provided valuable information on the region, and established the geological concept of the areas of Western Karakoram and Eastern Hindu Kush. One of his contributions in this work was the discovery of Cretaceous molluscan and coral fossils at Yasin "in the cliffs behind the Rest House on the right bank of the river…" in 1914. He also made a sketch of the stratigraphic succession there. He found fossiliferous shaly limestone containing large number of Fusulinae and Bryozoa near Darband that appeared to be underlain by massive limestones and shales, often calcareous. Although not studied in situ because of bad weather, he correctly inferred that the hills on either side of the glacier at Darkot were granitic.
Key Words: Geology, Chitral, Gilgit, Pamirs, Hindukush.

H/101. Hayden, H.H., 1918. Notes on the relationship of Himalaya to the Indo-Gangetic Plain and the Indian Peninsula. Geological Survey of India, Record 43(2), 138-167.

Key Words: Himalaya, Indian Peninsula.

H/102. Hayland, F.D., 1957. Mineral resources of Pakistan. Mineral Trade Notes (US Bureau of Mines) 45(6), Special Supplement, 49-50.

This account gives a brief on the mineral resources of Pakistan including those of the Northern Punjab and N.W.F.P.
Key Words: Mineral resources.

H/103. Head, J.J., 1995. Two new trionychids (Reptilia: Testudines) from the Miocene of Pakistan: evolution of Aspideretini. Journal of Vertebrate Paleontology, 15 (supplement 3), 33A.

Two skulls from the middle and late Miocene Chinje Formation of the Siwaliks deposits of the Potwar Plateau, Pakistan, represent two new species of trionychid turtle. The first specimen is a member of the tribe Aspideretini, based on several morphological characteristics: the basisphenoid is medially constricted and the quadrate is separated by the trigeminal foramen by contact between the pterygoid and the prootic. The specimen is dated at 14 MYA, and is the oldest known member of Aspideretini. The second specimen is a member of the tribe Ulutrionychini, and is the most complete skull known for the tribe. This assignment is based on: shortened facial region with downturned prefrontals and weakened maxillary-prefrontal contact. Medial constriction of the basisphenoid in this specimen is shared with Aspidereini. The specimen is dated at 12 MYA, and is the youngest member of the tribe.
This new material supports the hypothesis that Aspideretini are derived from Ulutrionychini. In addition, the presence of an ultrionychid in younger strata than an aspideretid suggests that Ultrioneychini persisted for a minimum of 2 MYA after the derivation of Aspideretini.
Key Words: Paleontology, Miocene, Chinji formation, Potwar, Siwaliks.

H/104. Head, J.J., 1997. Reptile palaeontology of Dhok Pathan Formation, Siwalik Group, Pakistan: Preliminary results. Abstracts, 3rd GEOSAS Workshop on Siwaliks of South Asia, Islamabad. Geological Survey of Pakistan, Records 109, 58-62.

Mammalian paleontology of the Siwalik Group of Pakistan has been heavily studied in regards to taphonomy, paleoecology, and phylogenetics, however, reptile fossils from the Siwaliks have received much less attention. The majority of reptile studies have been taxonomic depositions (e.g. Lydekker, 1885), and brief paleodlimatic reconstructions based on reptile occurrences from the Siwaliks of Nepal (West et al., 1991). Presented here are the preliminary results of what is intended to be an extensive survey of the Siwaliks herpetofaunas, emphasizing changes in ecology and phylogenetics through time.

Reptile fossils were surface collected at 31 localities throughout the middle and upper Dhok Pathan Formation in the Padhri-Hasnot region during March, 1996. These localities comprise a timespan of approximately 7.92-6.3 Ma (J.C. Barry, pers. comm.). Reptile taphonomy of these localities is similar to conditions described for mammals from the Dhok Pathan Formation (Badgley et al, 1995), with the exception of skeletal element frequencies; turtles are predominantly represented by shells, and snakes exclusively by vertebrae. These differences are due to the unique morphologies of the reptile groups. No complete specimens were recovered, and articulation of skeletal elements was nearly absent with the exception of several snake vertebrae and a partial trionychid turtle carapace. The incomplete nature of the specimens, combined with difficulties in phylogenetic assignment of represented taxa (e.g. Gardner and Russell, 1994) prevents species-level assignments at this time.

Due to both their scarcity in preservation and difficulties in phylogenetic determinations, squamate fossils are only briefly discussed here. Remains were recovered from only five localities, with the majority of remains recovered from a single locality, Yale 935, which contained vertebrae of possibly two partially complete snake specimens. Snakes are the most abundant squamate remains, and several specimens are nearly identical to, Acrochordus, a taxon known only from the Siwaliks and modern Indonesia/Australia (West et al., 1991). Lizards are poorly represented, with only several vertebrae from locality Yale 457, questionably referable as varanoid.

Historically, there have been at least five named crocodilian species from the Siwaliks: Crocodylus palaeindicus, C. sivalensis, C. bugtiensis, Gavialis hysudricus, and Rhamphosuchus crassidens (Lydekker, 1885; C. Brochu, pers. comm.). Remains from the Padhri Hasnot region consist of Crocodylus sp., Gavialis sp., and single tooth, possibly referable to Rhamphosuchus. (West et al., 1993) tentatively described Tomistoma sp. from the Siwaliks of Nepal, however, no definitive evidence of this taxon was recovered from the Dhok Pathan Formation. Size ranges of crocodilians include extremely small (tooth crown height .75 cm: neonate/juvenile) to extremely large (tooth crown height 4.2 cm: Rhamophosuchus?), with no apparent pattern of size increase or decrease through time. Turtle remains are the most abundant reptile fossils. All recovered specimens can be grouped into two main lineages, Trionychoidea (aquatic turtles) and Testudinoidea (semi-aquatic and terrestrial turtles). There is no definite evidence of pleurodiran turtles. Tronychoids are the most common reptile fossils, and their diversity includes carretocheyids and both cyclanorbine and trionychine trionychids. Carreteocheyid specimens are diagnosed on the basis of punctate shell sculpturing; lack of acute sulci combined with the presence of peripheral bones; and the extension of sculpturing to the internal surfaces of the shell (Meylan, 1987; W. Bartels, pers. comm.). Among trionychids, the presence of cyclanorbines is indicated by partial epiplastra, similar to the extant Asian species Lissemys puncfata (Meylan, 1987). Trionychines are diagnosed by fragmentary plastra. At least one trionychine specimen may be referable to a specific genus; a partial carapace from locality Yale 933 retains a preneural element, a characteristic of the genus Aspideretes (Meylan, 1987).The taxonomic utility of this characteristic has been argued as being undiagnostic (Meylan, 1987; Gardner and Russell, 1994), however, the tentative assignment to this genus is corroborated by the endemicity of modern aspideretids to Asia, and the occurrence of earlier members of this lineage in the Chinji Formation (Head, 1995). Size ranges for aquatic turtles range from diminutive (carapace length less than 15 cm) to extremely large, with localities, Dartmouth-Peshawar 13 and 28, containing remains of trionychid carapaces longer than 100 cm.

Testudoideans include emydid, batagmine, and testudinid turtles. Emydids are recognized on the basis of low-domed carapaces, lack of extensive shell ornamentation, and the presence of a plastral hinge (Emydid morph “A”, Fig. 1) in adult specimens. Six forms of batagurine turtles have been recognized from the Siwaliks of Nepal (West et al., 1991), on the basis of shell fragments. Similar fragments have been recovered from the Dhok Pathan, however, differentiating between testudinids and batagurine remains from the Padhri-Hasnot region is tenuous at best. Among definitive testudinids, the species Geochelotie is recognized by an epiplastron possessing a prominent cranial buttress. The distribution of this genus in Pakistan and India spans the Oligocene to Plio-Pleistocene of Pakistan to present of India (Auffenberg, 1974). An additional testudine taxon is represented by neural elements possessing extremely high, transverse crests. As with trionychids, emydid specimens recovered at locality Dartmouth-Peshawar 13 are extremely large, with carapace lengths approaching 100 cm. Large size testudinids (greater than 50 cm carapace length) were recovered from localities dated at 7.3 Ma and younger. The presence of these large testudinids indicates a mean cold month temperature of warmer than 20º C (Hutchison, 1982). An increased aridity in the Siwaliks at 7 Ma has been reported, based on Dhok Pathan rodent faunas (Jacobs and Flynn, 1981) and a transition from C3 to C4 photosynthesis (Quade and Cerling, 1995). The expected results of increased aridity on the reptile faunas wou1d consist of an increase in diversity and abundance of taxa adapted for more xeric environments, and a decline in aquatic forms due to the reduction of surface water area. The occurrence of large testudinids from 7.3 Ma on may represent an influx of xeric (though not exclusively so) species. Aquatic taxa do not show decreases in diversity or abundance prior to 6.3 Ma, however. The largest specimens of all aquatic taxa occur between 6.6 and 6.3 Ma, and there is no demonstrable decrease in reptile abundance per locality after 7 Ma. Overall, reptile fossils

from 7 Ma on indicate that even with the increased aridity, large, permanent aquatic environments persisted, allowing both rich taxonomic diversity and the attaining of long life spans/body sizes in the aquatic herpetofaunas.
Further research is required to confirm or deny these preliminary observations, as this study is still in its infancy. Future analysis will include changes (or lack thereof) in reptile diversity over a greater range of time, as well as spatial variations in herpetofaunas, through the Siwaliks. Additionally, further collection of specimens may allow observations of species longevity and evolutionary transitions of reptiles over time.
Key Words: Paleontology, Dhok Pathan formation, Potwar, Siwaliks.

H/105. Heintz, E. & Brunet, M., 1982. Une barriere geographique entre le sous-continent indien et Eurasie occidentale pour les faunes continentals du Miocene superieur. Comptes-Rendus des Seanes de l’Academie des Sciences, Serie2: Mecanique-Physique, Chimie, Sciences de l’Univers, Sciences de la Terre, 294, 477-480.

Key Words: Geography, fauna, Miocene, India, Eurasia.

H/106. Heissig, K., 1972. Palaeontologische und geologische unter suchungen im Tertiar von Pakistan. –Rhinocerotidae (mamm.) aus den unteren und mittleren Siwalik-Schichten. Bayer. Akad. Wissensch., Math. Nature. Kl. Abh. 152, 1.112.

Key Words: Paleontology, geology, Tertiary, Siwaliks.

H/107. Hemphill, W.R. & Danilchik, W., 1966. Geologic interpretation of the Gemini V photograph of the Salt Range-Potwar Plateau region, West Pakistan. NASA Earth Resources Survey Programm, Technical Letter 40. Houston, Texas.

Key Words: Geology, satellite imagery, Salt Range.

H/108. Hemphill, W.R., & Kidwai, A.H., 1973. Stratigraphy of the Bannu and Dera Ismail Khan areas, Pakistan. US Geological Survey, Prof. Paper 716-B, 36p.

The Bannu and Dera Ismail Khan quadrangles cover an area of more than 8,600 square miles in north-central Pakistan, between lat 31 and 33°N and long 70 and 71°E. This area contains two main physiographic units: the alluvial lowlands, which include the structurally undisturbed Indus and Bannu plains and the folded belt which includes the Khisor, Marwat, Bhittanni and Sulaiman Ranges, as well as the highlands of Waziristan. These ranges and highlands form a nearly continuous mountain system between the Salt Range-Potwar Plateau region to the northeast and Baluchistan to the southwest.
Total stratigraphic thickness exceeds 14,000 feet in the Khisor and Marwat Ranges. Sedimentary rocks of the following age are present: Cambrian (?). Permian, Triassic. Jurassic, Cretaceous, middle and late Tertiary, and Quaternary. Lower Tertiary rocks are not present. Stratigraphic terminology for rocks in the Khisor and Marwat Ranges is the same as that used in the Salt Range and Potwar Plateau region to the northeast.
Total stratigraphic thickness exceeds 38,000 feet in the Sulaiman Range-Waziristan area. Sedimentary rocks of Jurassic, Cretaceous, Tertiary, and Quaternary age are present. Rocks of Paleocene and Eocene age are particularly well developed in this region, in places exceeding 13,000 feet. Stratigraphic terminology for units of Mesozoic age is the same as that used in Baluchistan to the southwest. New names are proposed and type sections are designated for seven units in the eastern foothills of the Sulaiman Range. These units are the Baska Shale of early Eocene age; the Domanda Shale and Drazinda Shale Member of the Kirthar Formation, middle and late(?) Eocene age; the Chitarwata Formation of late Oligocene to late Miocene age; and the Vihowa, Litra, and Chaudhwan Formation of Pliocene and Pleistocene (?) age.
Key Words: Geology, stratigraphy, Bannu, D.I.Khan.

H/109. Hemphill, W.R., Kidwai, A.H. & Jamiludin, 1962-64. Geologic Map of Bannu quadrangle, Pakistan. US Geological Survey, Geological Map Series PP716B Plate 2. Scale 1:250,000.

A geological map of the Bannu quadrangle is produced at 1:250,000 scale. For further information, consult the following.
Key Words: Geological map, Bannu.

H/110. Henderson, G. & Hume, A.O., 1873. Lahore to Yarkand incidents of the route and Natural History of the countries traversed by the expedition of 1870 under Forsyth, T.D., Roy. Geographic Society, London, 370p.

On the return to India of the Yarkand Expedition it was believed that sufficient materials had been collected, during the journey, for a paper in some scientific journal, on the Zoology and Botany of the countries traversed, but in preparing the notes for the press it was soon found that their bulk was so great as to necessitate a separate. After everything was ready for publication, the Secretary of State for India in Council most liberally subscribed for a number of copies of the work, sufficient to relieve the Authors of almost all risk. The sale of such a work as the present must necessarily be very limited. The Authors have to acknowledge with thanks the assistance they have received from many kind friends. Dr. Hooker most liberally allowed the Kew Herbarium to be freely consulted in" identifying the Botanical specimens, and he and Mr. Bentham have written the descriptions of the new species of flowering Plants, all of which have been figured by Mr. Fitch, under Professor Oliver's supervision ; and Mr. James Britten, late of the Kew Herbarium and now of the British Museum, gave very great assistance in identifying specimens of Plants ; he also kindly undertook to revise the proof sheets of the botanical portion of the work. The identifications and descriptions of Algae, Diatomaceae, &c., as also the drawings of these, are by Dr. Dickie of Aberdeen, Mr. Fitch having lithographed the drawings. The Ornithological portion of the work has been edited by Mr. E. B. Sharpe, and Mr. H. W. Bates has exercised a general supervision over the work, whilst it was passing through the press. The analysis of the water of the Pan gong Lake was kindly undertaken by Dr. Frankland, and is published with his permission. Mr. Etheridge, of the Royal School of Mines, kindly identified the only fossil which was found in Yarkand territory, and his prognostication that coal would probably be found in Yarkand has already turned out to be true, for Mr. Shaw has informed Dr. Henderson that specimens of coal have since been obtained in Yarkand territory. Mr. Scott, of the Board of Trade Meteorological Office, kindly allowed the observations of the barometer, boiling-point thermometer, and the wet and dry bulb thermometer to be worked out in his office. The Map was drawn by Mr. Oulet at the Royal Geographical Society's rooms, under the supervision of Mr. Bates. The Plates which illustrate the Narrative, if not all works of art, have at least this recommendation, over woodcuts, that they give a truthful representation of the places, without leaving any margin for the imagination of the artist; all these Plates are done by the new Heliotype process, from negatives which were never very good, and which suffered greatly by the rough treatment they were subjected to during the march. It should be mentioned that these views are all reversed i.e., the right hand side of the picture should have been at the left side, and vice versa; this was caused by the negatives having been varnished at the time they were done, which prevented the film being taken off and reversed. The Plates of Birds are all by Keulemans, and with scarcely an exception they are all very accurately done. Few who have not themselves attempted it can realize the difficulty of getting through the press a volume like the present, containing such a variety of information; notwithstanding all the care that has been taken some mistakes may have been over- looked.
Key Words: Lahore, Yarkand, Expedition, Natural history.

H/111. Henderson, W., 1859. Memorendum on the nature and effects of the flooding of the Indus on 10th August 1858 as ascertained at Attock and its neighbourhood. Journal of the Asiatic Society of Bengal 28, 199-219.

As this account does not have an abstract, the first few pages of this account are given for information.
I begin by observing that this is not the first flood of the sort, but that one on a somewhat larger scale, but in other respects very similar, took place in May, 1811. I have seen two very brief accounts of this flood, one I think collated by Col. Abbott, the other furnished by Col, Cunningham. I have also collected at Attok and the neighbourhood some

information on the effects of this earlier flood; and as the two are very similar and mutually throw light upon one another, I shall have to refer to that of 1841, and so premise this allusion to it.

The first point on which information is called for is the spot where the obstruction took place. This can only be ascertained by sending up an Officer by way of Cashmere. In the meantime I may offer a few observations.

The obstruction of 1811, took place in the upper part of the valley of the Shayok River or northern Indus which joins what is considered as the main Indus at Keris, and I think brings down more water than the other, which from its long and straight course is naturally considered the principal or parent stream. The blocking took place in the part of the Valley where the stream runs at the back of a high range which separates it from the Nubra Valley. I have been over this ground and was struck with the frequency and solidity of the glaciers which occupy almost every valley in the range, with their tributary glens also. The range is granite, and large rough blocks of that rock form an important component of these glaciers.

The first information was received in the neighbourhood of Attok about the middle of July 1858, and of all that I have heard of, that which appeared most worthy of credit was a letter forwarding what purported to be a general warning by the Syuds of Kangra or Kangri. The Attok boatmen declared at once that the warning received in 1841, emanated from the same place; they recognized the style and stated that the same form of adjuration was employed and that the signatures appended were the same, except that two or three individuals, who might fairly be supposed to have died in the interval, were omitted from the later document. Search was then made in the house of Bulloo, the oldest of the Mullicks of the boatmen, but though it was well known that the paper was preserved there till a year or two ago, the search proved unsuccessful.

There is a village named Kangri marked in the Surveyor General's map of the Punjab and adjoining countries, and I believe this is the place alluded to, it is at no great distance from the Nubra and Shayok Valleys, and if the fact be that both papers issued from it, a fair inference is that in both cases the obstruction was at no great distance from its site; for in these valleys such news would not travel far except it were down the course of the river. We know that the damming of 1841, took place within two or three days' march of the village, and, till better evidence be obtained, can but conjecture that this also occurred in the Shayok or in the Nubra valley. Both are well adapted for the purpose, being w r ide with strangulations at intervals, having comparatively a small slope of bed and being supplied from large glaciers above with considerable and unfailing streams of water. For though the main fall of the Indus-bed takes place between Kangri and Attok, yet the general character of all the streams I have observed in the Himalayas is to fall in steps, a comparatively sluggish portion intervening below the first rush of the minor tributaries, to be succeeded by the main stream making its way in a series of rapids for two or three hundred miles. Both the Nubra and the upper Shayok are thus comparatively slow flowing, and in the former especially there are numerous quicksands.

I have two or three times crossed the Shayok, and found it in the summer time a stream of considerable size. On the other hand, and contradictory to the above, all Major Becher's information pointed to the river of Gilgit, and that pretty consistently; but as this cannot be reconciled to the facts I have noted, as I understand them, I am inclined, till more evidence is obtained, to discredit it. I do not find in the map alluded to glaciers marked so far west as the River of Gilgit nor are the mountains from which it comes so high or so snow-clad as those to the eastward. Indeed I do not know in any part of the Himalayas a region so likely to give birth to catastrophes of the kind as that around the upper part of the Shayok.

The solution of the point is, however, very easy. The whole Indus above the Gilgit river is open to travellers proceeding under the protection of the Maharaja of Cashmere, and any officer starting from that valley and striking the Indus at the foot of the Nunga, Purbut, (a route which I recollect an officer of the artillery following in the summer of 1855,) and thence marching upwards, would very soon ascertain positively the exact locality of the obstruction. I should be glad if opportunity offered to proceed further for the purpose, and regret that when in that country before, I gave less attention to the matter than I should have done had I thought that a flood like that of 1841, could by any chance occur again in any definite number of years.

The second point mooted is the nature of the obstacle. We may pronounce with almost certainty that this was the sudden irruption into a comparatively narrow valley of an immense fragment of a glacier. I have already alluded to the glaciers of the region where I suppose the obstruction to have taken place. I have never seen those of Switzerland, but from what I have heard of them I think that the ones now referred to differ from the character ordinarily assigned to those in Europe, as they certainly greatly excel the latter in magnitude. Yet even in Europe a catastrophe similar to those which have taken place in the Indus valley occurred in that of the Drance in 1818. When crossing from the Nubra to the Shayok valley in August 1855, my companion, who had been in Switzerland, would at first hardly admit that the enormous mass of earth, rock and ice commingled and agglomerated together, with a broad stream of the dirtiest brown water issuing from its foot, and which I pointed out, filling up a tributary valley on our left, was really a glacier; (There are however glaciers in every direction and some remarkable ones. Eds.)

and several hundred miles farther south crossing the great shed between the Lanskar and the Chenab, he pointed out the features he had been accustomed to see, and which we generally find in description, clear ice of various tints of green, and deep crevasses crossed by snow bridges, and with comparatively clean water running within them. The formation in this case was lime-stone, in the former case granite. With regard to the magnitude of these glaciers
I need only say that I travelled nearly a whole day along one which was upwards of fourteen miles in length, varying in width from half a mile to two miles, and several hundred feet in depth.
The glaciers are, it is well known, in constant motion; their progress being subject to the same laws which regulate the motion of rivers. As they advance, their ends melt away and the Moraine gets washed down by the streams that issue from the body of the glaciers. The flow of one glacier measured by Prof. Forbes showed an onward movement of about 450 feet per annum, and it is evident, that where a glacier is cut off above the melting point by a stream running past its end, this motion must make it tend very considerably to encroach into the valley of the stream.
A landslip in one of those huge banks is quite a conceivable contingency, and in no case more likely than when the glacier protrudes with a narrow base and extended top from a small feeding glen coming in, nearly at right angles, into a narrow valley, whose stream crosses the path of the glacier, washing away the narrow foot which the mass behind protrudes, and on which it rests. This foundation being once undermined, the falling forward of a piece of the glacier is the result to be expected; and it is possible that this result often takes place, but that it is not often that circumstances so combine as that the process is delayed till a mass of formidable dimensions topples over.
Key Words: Natural hazards, Indus flood, Attock.

H/112. Henn, U., 1988. Untersuchungen an smaragden aus dem Swat-Tal, Pakistan. Zeitschrift der Deutschen Gemmologischen Gesellschaft 37, 121-127.

Key Words: Emerald, gemology, Swat.

H/113. Heron, A.M., 1950. Directory of economic minerals of Pakistan. Geological Survey of Pakistan, Records 1(2), 70p.

This is one of the earliest compilation of the economic mineral deposits of the newly independent country of Pakistan.
Key Words: Mineral deposits.

H/114. Heron, A.M., 1953. History of geological surveys in Pakistan. Geological Survey of Pakistan , Records 4(2) 44p.

Key Words: GSP.

H/115. Heron, A.M. & Crookshank, H., 1954. Directory of Economic Minerals of Pakistan. Geological Survey of Pakistan, Records 7(2), 146p.

This is an earlier work of the GSP showing the economic minerals found in Pakistan. This record was compiled in the early days of Pakistan's independence.
Key Words: Economic minerals.

H/116. Herzberg, C., 1981. Pakistan debuts first official gemstones collection. Natural Jewel, United States, April, 1p.

Key Words: Gemology, gemstones, Pakistan.

H/117. Hess, H., 1939. Gletscherkundliches aus dem Karakorum. Petermanns Geographische Mitteilungen 85, 91-92.

Key Words: Karakorum.

H/118. Heuberger, S., Burg, J.P., Dawood, H. & Hussain, S., 2001. Mapping of the North-Kohistan Suture, Upper Shishi Valley, Chitral, NW Pakistan. Journal of Asian Earth Sciences 19, p.28.

The northern suture, also known as the Main Mantle Thrust, separates the Kohistan island arc from the Karakoram-Hindukush terrains. Its western end occurs in the Chitral area. The NE trending Shishi valley to the north of Drosh marks the trace of the junction between the volcanic and other rocks of Kohistan and the Karakoram-Hindukush terrain. The suture is marked by a mélange and contains slivers of ultramafic rocks.
Key Words: Mapping, North suture, MMT, Shishi valley, Chitral.

H/119. Hewitt, K., 1961. Karakoram glaciers and the Indus. Indus 2, 4-14. Lahore.

Key Words: Glaciers, Karakoram, Indus.

H/120. Hewitt, K., 1964. A Karakoram ice dam. Indus 5, 18-30. Lahore.

Key Words: Karakoram, Ice dam.

H/121. Hewitt, K., 1967. Ice-front sedimentation and the seasonal effect: A Himalayan example. Transaction of the Institute of Bristich Geographer 45, 93-106.

Key Words: Ice-front, sedimentation, Himalaya.

H/122. Hewitt, K., 1968a. The freeze-thaw environment of the Karakoram Himalaya. The Canadian Geographer 12, 85-98.

Frequent and large temperature shifts across freezing point are well-known features of tropical and sub-tropical high mountains (Troll). In a mountain environment particularly, these temperature shifts can powerfully influence weathering, mass-movements and run-off. Such was very apparent during field work in the Karakoram. So far as the writer is aware, there has been no attempt to analyse the freez-thaw conditions in the semi-arid Himalaya. This paper sets out to reduce the gap in our knowledge by presenting in detail results from metereological observations made in 1961 -62 in Central Karakoram; and with the aid of certain other published records, to establish the altitudinal and seasonal migration of freez-thaw belt.
Key Words: Environments, Karakoram, Himalaya.

H/123. Hewitt, K., 1968b. Records of natural damming and related events in the upper Indus basin. Indus 10, 11-19. W.L. University, Waterloo, Ontario.

Key Words: Natural damming, Indus basin.

H/124. Hewitt, K., 1969a. Geomorphology of the mountain regions of the upper Indus basin. Ph.D. Thesis. London University, 2 Volumes., 310p. and 121pl.

Key Words: Geomorphology, Indus basin.

H/125. Hewitt, K., 1969b. Glacier surges in the Karakoram Himalaya (Central Asia). Canadian Journal of Earth Sciences 6, 1009-1018.

The Karakoram and Alaska–Yukon region between them account for perhaps 90% of the known surging glacier events. While modern research and information is available for the latter region, the Karakoram, though often referred to, remains virtually unknown except in a very general sense. The prime aim of this paper is to collate all the information that is available for the Karakoram from the usually old and inaccessible documents where it is found. It establishes eleven instances of surges with reasonable certainty and the probability of many more. The (rare) instances of detailed descriptions of the phenomena are quoted. A short discussion is given of the degree to which the information, and knowledge of the Karakoram environment, equate with various mechanisms put forward to explain surging glacier events.
Keywords: Glaciers, Karakoram, Himalaya.

H/126. Hewitt, K., 1975. Prospective on disaster and natural hazards in the Northern Areas. Dawn Magazine, January, 1-12.

Consult the following description for further information.
Key words: Natural hazards, Karakoram.

H/127. Hewitt, K., 1982. Natural dams and outburst floods of the Karakorum Himalaya. IAHS-AISH Publication 138, 259-269.

Glacier dams and outburst floods ("jokulhlaups") have been reported in many glacierized mountain regions, and may create hazards for human populations. Specially large and dangerous examples occur where the rivers of extensive ice-free zones are blocked. This hydrological anomaly has been rare in modern times except for two areas: the southern Alaska-Yukon ranges and Karakoram Himalaya. In the Karakoram some 30 glaciers may form substantial dams on the Upper Indus and Yarkand river systems. Many more interfere with the flow of rivers in a potentially dangerous way. There is evidence of some 35 disastrous jokulhlaups since 1826. Rarer landslide dams have resulted in the largest dam-burst floods. The paper provides a record of known dams and related events, and identifies the glaciers involved. It indicates the role of the regional environment in the widespread potential for these glacier dams and catastrophic outbursts. Some data are given on the dimensions of past dams and the nature and impact of the flood waves. No dams were reported from the mid 1930's until 1978 when satellite imagery showed a 6 km glacier lake on the Upper Yarkand. The absence of dams in recent decades relates to a general glacier recession here. Renewed activity creates serious problems for water resource development and settlement growth that occurred in the recent, unusually favourable period.
Key words: Natural dams, glaciers, floods, Karakoram, Himalaya.

H/128. Hewitt, K., 1985a. Pakistan Case Study: Catastrosphic floods. IAHS-AISH Publication 149, 131-135.

Within the highly glacierized karakoram Himalaya situated largely within Pakistan, there have been many cases of catastrophic floods, some the result of river damming by landslide, Others the result of river damming by glacier ice with subsequent dam failure. The purpose of this case study is to show, by reference to one particular example, the magnitude and consequences of a glacier outburst flood and possible ways of alleviating the social and economic impact of such floods. This case study is taken from a much more extensive paper on the subject by Hewitt (1982).
Key words: Glaciation, floods, landslides, Karakoram, Himalaya.

H/129. Hewitt, K., 1985b. Snow and ice hydrology in remote, high mountain regions: The Himalayan sources of the River Indus. Wilfried Laurier University, Waterloo, Snow and Ice Hydrology Project Working Paper 1.

Key words: Snow, Ice, Hydrology, Indus River, Himalaya.

H/130. Hewitt, K., 1985c. The Upper Indus snow belts; snow fall and sources of water yield. 1985 Annual Report: Snow and Ice Hydrology Project (upper Indus basin). Wilfred Laurier University, Waterloo, Ontario.

Key words: Snow, ice, hydrology, Indus River, Himalaya.

H/131. Hewitt, K., 1988a. The snow and ice hydrology project: Research and training for water resource development in the Upper Indus basin. Journal of Canada-Pakistan Corporation 2(1), 63-72.

Key words: Snow, ice, hydrology, Indus River, Himalaya.

H/132. Hewitt, K., 1988b. Ablation valley landforms and depositional environments of the Karakoram Himalaya. Altitude, Process and Clima-Geomorphic change. Conference abstracts, Neogene Karakoram and Himalayas. University of Leicester.

Key words: Ablation, landforms, Karakoram, Himalaya.

H/133. Hewitt, K., 1989a. The altitudinal organization of Karakoram geomorphic processes and depositional environments. In: Derbyshire, E. & Owen, L.A. (Eds.), Quaternary of the Karakoram and Himalaya. Zeitschrift fur Geomorphologie, Supplementeband 76, 9-32.

Key words: Geomorphology, Karakorum.

H/134. Hewitt, K., 1989b. European Science in High Asia: Geomorphology in the Karakoram Himalaya to 1939. In: Tinkler, K.J. (Ed.), History of Geomorphology: From Hutton to Hack Unwin Hyman, London. 165-203.

Key words: Geomorphology, Karakoram, Himalaya.

H/135. Hewitt, K., 1989c. Hazards to water resources development in high mountains: The Himalayan sources of the Indus. In: Starosolsky, O. & Medler, O.M. (Eds.), Hydrology of Disasters. WMO/James and James, London. 294-312.

Key words: Water resources, hazard, Indus river, Himalaya.

H/136. Hewitt, K., 1992. Mountain hazards. Geo Journal 27, 47-60.

Key words: Hazarad.

H/137. Hewitt, K., 1993a. Mountain chronicles. Torential rains in Central Karakorum, 9-10 September 1992. Geomorphological impacts and implications for climatic changes. Mountain Research and Development 13, 371-375.

Key words: Geomorphology, climate change, Karakoram.

H/138. Hewitt, K., 1993b. Altitudinal organization of Karakoram geomorphic processes and depositional environments. In: Shroder, J.F. Jr. (Ed.), Himalaya to the Sea: Geology, Geomorphology, and the Quaternary, Routledge, 159-183.

Key words: Geomorphology, Karakorum.

H/139. Hewitt, K., 1998a. Catastrophic landslides and their effects on the Upper Indus stream, Karakoram Himalaya, northern Pakistan. Geomorphology 26 (1 – 3), 47-80.

The paper examines the nature and geomorphic influences of deposits from rock avalanches that obstruct rivers. Most of the 115 rockslide–rock avalanche events identified in the Karakoram Himalaya straddled one or more stream valleys. At least 73 of these landslides formerly dammed the Indus or its tributaries. Upstream of the barriers, remnants exist of once very extensive lacustrine deposits. The stability and long-term survival of dams from large rock avalanches is addressed, and the reasons for the gradual or phased, rather than catastrophic and sudden, breaching. Case histories emphasise the erosional and depositional forms associated with the barriers. They are reconstructed in terms of the emplacement and properties of the deposits from rock avalanches, and the response of the river to interruption by them. These barriers have exerted a substantial control over stream response and development for most of the Holocene at least. Today, they are associated with distinctive features of channel form and thalweg, river terrace systems, intermontane sediment sinks and sources, and local erosional forms in bedrock. More broadly, the landslide barriers have created a naturally fragmented river system. Deposition and erosion in the lower few tens or hundreds of meters of the Upper Indus stream valleys have been dominated by epicycles of aggradation, trenching, and downcutting that mainly reflect the scale, timing and history of each barrier. The landforms involved are only indirectly related to the late-glacial and paraglacial conditions that have, hitherto, been regarded as the main explanation.
Key words: Landslides, Karakoram, Himalaya, Indus streams.

H/140. Hewitt, K., 1998b. Himalayan Indus streams in the Holocene: Glacier-, and landslide-‘interupted’ fluvial systems. In: Stellrecht, I. (Ed.), Karakorum-Hindukush-Himalaya: Dynamics of change. Rudiger Koppe, Koln (Culture Area Karakorum, Scientific Studies 4).

Key words: Glaciers, landslides, Indus streams, Himalaya.

H/141. Hewitt, K., Wake, C.P., Young, G.J. & David, C., 1989. Hydrological investigation at Biafo Glacier, Karakorum Range, Himalaya; An important source of water for the Indus River. Annals of Glaciology 13, 103-108.

Over 80% of the flow of the Upper Indus River is derived from less than 20% of its area: essentially from zones of heavy snowfall and glacierized basins above 3500 m elevation. The trans-Himalayan contribution comes largely from an area of some 20 000 km2 of glacierized basins, mostly along the axis of the Greater Karakoram range and especially from 20-30 of the largest glacier basins. Very few glaciological investigations have so far been undertaken in this the major glacierized region of Central Asia. Biafo Glacier, one of the largest of the Karakoram glaciers, drains south-eastwards from the central Karakoram crest. Its basin covers a total area of 853 km2, 628 km2 of which are permanent snow and ice, with 68% of the glacier area forming the accumulation zone. This paper describes investigations of snow accumulation, ablation, glacier movement, and glacier depth undertaken in the period 1985-87, set against a background of investigations carried out over the last 130 years. Biafo Glacier differs from most of the other Karakoram glaciers in being nourished mainly by direct snowfall rather than by avalanching; this has the advantage of allowing extensive investigation of accumulation over a broad range of altitude. Snow-accumulation studies in the Biafo Glacier basin have indicated that annual accumulation varies from 0.9 to 1.9 m of water equivalent between 4650 and 5450 m a s.l. This suggests an annual moisture input above the equilibrium line of approximately 0.6 km3. Monopulse radar measurements indicate the presence of ice thickness as great as 1400 m at the equilibrium line, although these results may not be completely reliable. Mean surface velocity during the summer of 0.8 m d-1 has been measured near to the equilibrium line. Calculations of annual ice flux through the

vertical cross-profile at the equilibrium line indicate a throughput of 0.7 km3 a-1 Estimates from stake ablation measurements also suggest that ice loss on Biafo Glacier is about 0.7 km3 a-1. The close agreement between these three sets of measurements is reassuring, indicating that the ablation zone of Biafo Glacier, whose area covers 0.09% of the whole Upper Indus basin, produces approximately 0.9% of the total run-off. However, it should be mentioned that this estimate does not include water originating from seasonal snow melt, either above or below the equilibrium line, or from rainfall. Net annual ice losses due to wastage of the glacier since 1910 are probably of the order of 0.4-0.5 m a-1; this would represent between 12 and 15% of annual water yield from melting ice.
Key words: Glaciers, Biafo, hydrology, Himalaya.

H/142. Hewitt, K. & Young, G.J., 1993. The Snow and Ice Hydrology Project: A Pakistan-Canada Research and Training Programme. In: Young, G.J. (Ed.), Snow and Glacier Hydrology - Proceedings of the International Symposium, Kathmandu, 1992. Wilfried Laurier University, Waterloo, Ontario, 49-59.

The paper describes the inception, implementation and possible future developments of the Snow and Ice Hydrology Project (SIHP), a joint Pakistan-Canada venture. Conceived in 1981, the project entered its first of five summer field seasons in 1985. The project was requested by Pakistan's Water and Power Development Authority (WAPDA), and was funded jointly by WAPDA and by Canada's International Development Research Centre. It involved several Canadian and other universities. In Canada the project was coordinated by the Cold Regions Research Centre of Wilfrid Laurier University. Recognizing that the Indus river is fed largely by melting ice and snow in the Karakoram Mountains and that there is insufficient understanding of the processes of snow and ice melt in this region, the SIHP's main objectives have been to set up within WAPDA a capability for undertaking relevant research, initiating and developing that research and laying the basis for a more operationally focused programme in the future. Field projects have included the setting up of meteorological monitoring stations at relatively high elevations, monitoring snowmelt in basins with and without glaciers and monitoring glacier ice melt in several basins in the Central Karakoram. Office work has included analysis of the data collected as well as the setting up of data bases and inventories of glacier coverage of the region. Technology transfer has been achieved through Canadian professors and students undertaking field work in Pakistan with their counterparts and through several Pakistani officers undertaking formal studies at Canadian universities. Based' on the understanding and the experience gained through SIHP, the project has now entered an operational phase with involvement of the Canadian International Development Agency. Recommendations for future work are given.
Key words: Glaciers, hydrology, Himalaya.

H/143. Hildebrand, P.R., 1996. The Structure, Metamorphism and Magmatism Observed in a Transect through the Hindu Kush, Northwest Pakistan. Abstract volume, 11th Himalaya-Karakoram-Tibet Workshop, Flagstaff, Arizona (USA), 62.

The Hindu Kush range of Northwest Pakistan is the along the strike equivalent of the well exposed and geologically relatively well studied southern Karakoram Range (Searle, 1991) and also what probably lies beneath South Tibet. The range occurs in the axial zone of two converging crustal subduction systems (the northward subducting Indian plate and the southward subducting Tadjik-Tarim plate) which are marked by the most seismically active zone on earth, where earthquakes have been recorded to depths of 300 km.

The transect studied occurs to the northwest of Chitral and the Shyok Suture which separates the Kohistan island arc from the Asian margin, and runs along the roughly west-east flowing Lutkho River. It is bounded to the east by the Reshun fault, which is a reverse fault, with a top to the east sense of movement, and which places greeenschist grade phyllites of the Asian margin onto relatively unmetamorphosed sediments of the Shyok Suture (Pudsey et al., 1985). The section contains metamorphosed and pots-deformation garnet-tourmaline tow mica leucogranite dykes and plutons.

The earliest recognizable deformation event (D1) occurred after the intrusion of the early porphyritic granites. D1 produced a penetrative WNW dipping schistocity (S1) that developed during and after the first recognizable metamorphic event (M1), which was up to garnet-staurolite grade. Near horizontal stretching lineation (L1) suggest that some strike-slip movement was associated with this early deformation.

Late deformation (D2) is spatially associated with the intrusion of leucogranites, and takes two forms, which may or may not be contemporaneous. The firs form is associated with the intrusion of the large Gharam Chasma leucogranite, pluton, which folds S1, producing horizontal N trending fold axes and crenulation lineations (L2), and ahs no effect on M1. The second form is associated with the emplacement of leucogranite dykes and sills during top the east movement along S1. Like the first from, this event produced folds with N trending, sub-horizontal fold axes (L2), suggesting that D2 involved dip-slip movement (as opposed to the D1 strike slip movement). However, this second form of D2 differs from the first in that it has a thermal overprint on M1, characterized by sillimanite-in and staurolite-out.

A limited amount of whole rock major and trace element geochemistry has been carried out on the Hindu Kush granites. The pre-deformation porphyritic granites are apparently different from the pre-collisional granites of the Karakoram, in that they are higher in K and Rb, and slightly lower in Sr, Ba and Ti. The post-deformation two mica-garnet-tourmaline leucogranites are typical peraluminous, near minimum crustal melt granites. They differ in their trace element compositions from the Karakoram post-collision Baltoro granites in that they are not similarly enriched in large ion lithophile elements and Th and Zr. The trace element compositions are more like the High Himalayan leucogranites such as those found at Langtang.

Key words: Structure, metamorphism, magmatism, Hindu Kush.

H/144. Hildebrand, P.R., 1997. Leucogranite gneisses in the Hindu Kush. Abstract volume, 12th Himalaya-Karakorum-Tibet International Workshop, Rome, Italy, 47.

The Hindu Kush Range of Northwest Pakistan is the along strike equivalent of the well exposed and geologically relatively well studied southern Karakoram Range (Searle, 1991) and also what probably lies beneath South Tibet. The range occurs in the axial zone of tow converging crustal subduction systems (the northward subducting Indian plate and the southward subducting Takjik-Tarim plate) which are marked by the most seismically active zone on earth, where earthquakes have been recorded to depths of 300 km.

Leucogranites in the Hindu Kush occur within highly graphitic, pelitic metasediments with minor amounts of calc-silicate and amphibolite. The pelitic sediments have been subjected to an early metamorphic event of garnet-staurolite grade. The leucogranites are associated with a later thermal metamorphism, characterized by sillimanite, andalusite and sometimes K-feldspar. This later metamorphism and leucogranite emplacement is also associated with late thrusting movement along faults.

The leucogranites occur as a large pluton (the Gharam pluton, Calkins et al., 1981), deformed bodies within migmatites, dykes and pegmatites. The structural relationships between these varieties are complex and difficult to interpret, although it appears that they are all broadly contemporaneous. They are peraluminous and consist of quartz, K-feldspar, plagioclase, biotite, muscovite and sometimes, tourmaline and or garnet. Although the structural relationships suggest a common origin between the garnet û staurolite schists, the migmatites and the varieties of leucogranites, geochemistry suggests that this is not the case. In particular the Sr isotope ratios for the Gharam Chashma ($^{87}Sr/^{86}Sr$=0.720-0.742). Interestingly these Sr ratios for the pluton are similar to those from the Baltoro pluton (Searle et al., 1992), suggesting a common origin.

Key words: Leucogranites, Hindukush.

H/145. Hildebrand, P.R., 1998. The Hindu Kush of Pakistan: mountain range evolution from active margin to continent-continent collision. PhD thesis, Oxford University, England.

Key words: Tectonics, orogeny, Hindukush.

H/146. Hildebrand, P.R., Noble, S., Searle, M., Parrish, R. & Shakirullah, 1998. Tectonic significance of 24 Ma crustal melting in the eastern Hindu Kush, Pakistan. Geology 26, 871-874.

Northward-directed subduction has continued beneath the Hindu Kush from the Mesozoic, when the region formed part of the southern margin of Asia, until today. The Kohistan arc was accreted at ca. 100 Ma, followed by the Indian plate at 54–50 Ma. After the India-Asia collision, a regional crustal-melting event occurred at ca. 25–21 Ma to the east of the Hindu Kush in the Karakoram Range, producing the Baltoro pluton. In the eastern Hindu Kush Range, most of the granitoids appear to be subduction-related plutons that predate the India-Asia collision. However, the Gharam Chasma pluton is a two-mica (± garnet ± tourmaline) leucogranite that has intruded into staurolite-grade schists and (sillimanite ± K-feldspar)–grade migmatites. U-Pb ages on monazite, xenotime, and uraninite from undeformed samples of the Gharam Chasma pluton and a leucogranite dike that crosscuts the migmatites indicate that crustal melting occurred at ca. 24 Ma, synchronous with the Baltoro melting event. This age also provides an upper limit on the age of the regional staurolite-grade metamorphism in the eastern Hindu Kush.

Key words: Tectonics, crustal melting, granite magmatism, Hindukush.

H/147. Hildebrand, P.R., Searle, M.P., Noble, S.R. Parrish, R.R., Shakirullah, 1998.The tectonic significance of 24 Ma crustal melting in the eastern Hindu Kush, Pakistan. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop, 77-79.

Northward directed subduction has taken place beneath the Hindu Kush from when it formed part of the southern margin of Asia in the Mesozoic, and still continues today. Accretion of the Kohistan arc took place at about 100-85 Ma, followed by the Indian plate at 55-50 Ma. After the India-Asia collision, a regional crustal melting event occurred around 25-21 Ma to the east of the Hindu Kush in the Karakoram range, producing the Baltoro pluton. In the eastern Hindu Kush range, most of the granitoids appear to be pre-India-Asia collision, subduction related plutons. However, the Gharam Chasma pluton is a two mica garnet ± tourmaline) leucogranite that has intruded into staurolite grade schists and sillimanite K-feldspar grade migmatites.

U-Pb ages on monazite, xenotime and uraninite from undeformed samples of the Garam Chasma pluton and a leucogranite dyke that cross cuts the migmatites indicate that crustal melting took place in the eastern Hindu Kush at around 24 Ma. This is contemporaneous with the event that produced the Baltoro pluton in the Karakoram, 400 km to the east. This extends the range and confirms the importance of widespread crustal melting in the southern margin of the Asian plate around the earliest Miocene.

The presence of lamprophyres with the same early Miocene age as the Baltoro pluton support the possibility of a mantle heat input to promote the crustal melting in the Karakoram [8]. In the eastern Hindu Kush, there is no indication of any lamprophyres or other potentially mantle derived melt that could potentially have a similar 24 Ma age, so alternative heat sources are required. The leucogranites in the Gharam Chasma area are spatially associated with sillimanite grade metamorphism and migmatites. Consequently, a more likely model for the generation of these leucogranites would appeal to peak metamorphism and decompression provide the heat and conditions necessary for melting. Such a model would be similar to models proposed for the generation of the High Himalayan leucogranites.

Key words: Tectonics, crustal melting, Garam Chashma granite, Lamprophyre, Hindukush.

H/148. Hildebrand, P.R., Searle, M.P., Shakirullah, Khan, A.Z. & Heijst, H.J.V., 2000. Geological evolution of the Hindu Kush, NW Frontier Pakistan: active margin to continent-continent collision zone. 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, 277-293.

A geological map of the eastern Hindu Kush, northwest of Chitral, Northern Pakistan, is presented. The lithologies are placed into two main categories, divided by the Tirich Mir Fault Zone. To the northwest, the units of the eastern Hindu Kush are dominated by monotonous sequences of graphite-rich pelitic rocks. Southeast of the fault, the phyllites and diamictites are thought to be lateral equivalents of the Northern Sedimentary Belt of the Karakoram. A structural analysis of the area studied identifies a major, early deformation phase which is usually characterized by tight to isoclinal folding with a well developed axial-planar schistosity. This deformation is thought to have been related to the northward-directed subduction and accretion beneath the southern margin of Asia during the Mesozoic, and may have taken place over a considerable period of time. A major phase of crustal melting at c. 24 Ma generated migmatites and biotite + muscovite ± garnet ± tourmaline leucogranites (including dykes and the Gharam Chasma pluton). This age is comparable to that of the Baltoro pluton in the Karakoram to the east, confirming the regional importance of crustal melting along the southern margin of he Asian plate during he earliest Miocene. The crustal melting was associated with thrusting and folding of the earlier schistosity. Subhorizontal stretching lineations indicate a phase of strike-slip deformation that is thought to have been associated with anticlockwise rotation of the regional foliation strike from E to NE and N after the emplacement of the Gharam Chasma pluton at c. 24 Ma. This deformation and rotation was probably a directed result of the northward-moving Indian plate forcing Kohistan to indent into Asia, resulting in a left-lateral transpressional tectonic environment

which remains today. The anomalous height of the Tirich Mir massif, relative to other peaks in the Hindu Kush and the nearby Hindu Raj, may be accounted for by the onset of this transpression.
Intensely active seismicity to depths of 300 km beneath the Hindu Kush is associated with seismic shear wave velocities that are significantly faster than those beneath Tibet, where earthquake occurrence is restricted to the upper crust, and previous geophysical studies indicate elevated thermal conditions and possible crustal melts. U-Pb ages suggest that post-India-Asia collision crustal melting beneath the Hindu Kush is restricted to c. 24 Ma, whereas in the Karakoram, the record is both more voluminous and more continuous from c. 37 to c. 9 Ma. These observations reflect major differences in the thermal histories of these regions, where the relatively cooler condition beneath the Hindu Kush are associated with continental subduction-related seismicity.
Key words: Tectonics, collision, Himalaya.

H/149. Hiller, K. & Ahmad, J., 1989. A subthrust play in the southeastern Potwar Depression. Pakistan Journal of Hydrocarbon Research 1, 14-17.

Key words: Geology, structure, Potwar depression.

H/150. Hirayama, J., Karim, T., Okamura, N., Hada, S. & Sato, M., 1995. A geological study and some feasibility considerations for the production of fused magnesium fertilizer (FMP) in Pakistan. Proceedings of Geoscience Colloquium; Geoscience Lab, Geological Survey of Pakistan, Islamabad, 11, 3-147.

Fued magnesium phosphate (FMP) is a phosphatic fertilizer consisting of P_2O_5, MgO, CaO, and SiO_2. It is ordinarily produced by fusing and quenching a mixture of quality-ore of phosphate containing more than 30 % of P_2O_5 and serpentinite. Substituting serpentinite as the material by magnesite is considered to not only make the utilization of low-grade ore of phosphate in the Hazara area possible but also promote the exploitation of under-developed magnetite in the same area. To verify the idea, a JICA team consisting of a mining engineer, a manufacturing engineer, and a fertilizer and marketing specialist was invited to conduct an extensive survey on mining costs of raw materials, production costs and the marketability of FMP under a close cooperation with Geoscience Laboratory, Geological Survey of Pakistan between May 23 and June 12, 1994. The conclusion of the study is that the manufacturing of FMP with 20% of P_2O_5 is feasible in Pakistan, if the following requirements are met:
1. The effectiveness of FMP be verified through experiments for various crops to be conducted by competent authorities;
2. Infrastructures required for the project, including access roads to mining sites and power supply, be consolidated by the Pakistani authorities concerned;
3. The Pakistani governments, Federal and Provincial, actively participate in implementing this project to extend necessary supports;
4. Financial and technical assistance for opting this project be offered from external resources including JICA.
Key words: Phosphate, Fused magnesium fertilizer.

H/151. Hirayama, J. & Mononobe, S., 1992. Pakistan is an underdeveloped treasure land-a perspective of new exploitation for unused mineral resources. Proceedings of Geoscience Colloquium; Geoscience Lab, Geological Survey of Pakistan, Islamabad, 3, 29-34.

Pakistan has got mineral resources which need to be exploited. This account gives information on reserves and potential for industrial use of Kakul phosphorite deposits and Kumhar magnesite deposits.
Key words: Exploitation, mineral resources, Pakistan.

H/152. Hirayama, J., Mononobe, S. & Karim, T., 1995. A proposal for the use of phosphorite and magnesite in Hazara division, NWFP, Pakistan. Geologica 1, 97-103.

Key words: Phosphates, Hazara.

H/153. Hochleitner, R., Weiss, S. & Weerth, A., 1991. Neu mineralfunde aus Pakistan und Afghanistan. Lapis 16(3), 15-16.

Stibiotantalite from Stak-Nala, Pakistan and tremolite from Nooristan, Afghanistan, are briefly described in this account.
Key words: Minerals, Afghanistan, Pakistan.

H/154. Hoffstetter, R., 1965. Les serpents du Neogene du Pakistan (Couches des Siwaliks). Bulletin de la Societe eologique de France, 7(6), 467-474.

Key words: Palaeontology, Siwaliks.

H/155. Holland, T.H., 1907. A preliminary survey of certain glaciers in the northwest Himalayas: Introduction. Geological Survey of India, Records, 35(3), 123–128.

Key words: Glaciers, Himalaya.

H/156. Holmes, D.A., 1968. The recent history of the Indus. The Geographical Journal 134, 367-382.

Key words: Geomorphology, Indus Rivers.

H/157. Hood, J.W., Khan, L. & Jawaid, D.K.H., 1970. Water resources and related geology of Dera Ismail Khan District, West Pakistan, with reference to the availability of groundwater for development. US Geological Survey, Water Supply Paper 1608-K, 74p.

Key words: Groundwater, water resources, geology, D I Khan.

H/158. Hora, S.L., 1936. The fish of Chitral. Records Indian Museum, 36, 307-310.

Key words: Palaeontology, Chitral.

H/159. Hora, S.L., 1937a. Fossil fish remains from the Saline Series of North western India. Geological Survey of India, Report 72(2), 188-194.

Key words: Palaeontology, Himalaya.

H/160. Hora, S.L., 1937b. Distribution of Himalayan fishes and its bearing on certain palaeogeographical problems. Indian Museum, Records, 39, 251-259.

Key words: Palaeontology, Himalaya.

H/161. Houstan, C. & Bates, R., 1955. K-2 the Savage Mountain. Collins, London, 192p.

This account contains general geographic details of the K2 Mountain, the second highest after Everest.
Key words: K-2, Karakoram.

H/162. Howells, M., 1976. The Biafo Peaks. Mountain 49, 38-41.

Key words: Glaciers, orogeny, Biafo.

H/163. Hubbard, M.S. & Spencer, D.A., 1990a. Indian plate deformation between Babusar pass and Nanga Parbat, NW Himalaya, Pakistan. In Abstract volume, 5th Himalaya-Karakoram-Tibet Workshop, Milano, 22.

The Nanga Parbat region of the northwest Himalaya has seen a complex tectonic history from the subduction of the oceanic India plate rocks beneath the Kohistan island arc; to collision of continental Indian plate rocks with Kohistan and southeast directed thrusting of Kohistan along the Main Mantle Thrust (MMT); to rapid exhumation of the Nanga Parbat massif, possibly by a combination of thrust faulting and erosion. We present preliminary results of a structural analysis of Indian plate rocks between Babusar Pass and Nanga Parbat. This study is aimed at a better understanding of the deformational history of this region and will help provide the much-needed geologic constraints for tectonic models of the area. Specifically we hope to distinguish deformation which is associated with the early collisional processes from later deformation which may be related tot he exhumation of the Nanga Parbat massif.

A traverse was made from Babusar Pass eastward to the Barai valley, the Toshe Gali area and north to the Indus valley at the village of Bunar. Work was predominantly within the Indian plate where lithologies are similar to those in the adjacent, upper Kaghan Valley. Gneiss, granitic-gneiss, and metapelite are overlain by a sequence of amphibolite, marble, and quartzite. In situ granitization of probable Himalayan age ahs affected the structurally lower units of the area. A pervasive stretching lineation is oriented EW to S50W with a shallow plunge. The origin and age of this lineation is, as yet, unknown. Folds are found from hand sample-scale to nappe-scale and the orientations of folds axes are parallel to the stretching lineations suggesting rotation of folds during the stretching deformation. Strike of schistosity is ÷N45-55E in the western part of the study area, but becomes more NS toward the west, near the contact with the Nanga Parbat gneiss. The stretching lineation is less pronounced in the Nanga Parbat gneiss. Future fieldwork will target: the possibility of late, brittle faulting in the area; the geometry of the nappe-scale; the relationship of the stretching lineation to MMT deformation or to the exhumation of the Nanga Parbat massif.

Key words: Deformation, Indian plate, MMT, Kohistan, Himalaya, Karakoram.

H/164. Hubbard, M.S. & Spencer, D.A., 1990b. WSW-trending deformation between Babusar pass and Toshe Gali area, northern Pakistan. Geological Bulletin, University of Peshawar 23, 101-110.

The Himalaya and Karakoram Mountain ranges of northern Pakistan are the product of multiple deformational phases from continental collision events that trapped the Kohistan island arc between the Asian and Indo-Pakistan plates to the development and emergence of the Nanga Parbat syntaxis. Fieldwork along the Main Mantle Thrust (MMT) and within the Indo-Pakistan plate rocks in the area between Babusar Pass and Toshe Gali was aimed at an understanding of the kinematic relationship between these deformational phases. The MMT is the suture between rocks of the Indo-Pakistan plate and rocks of the Kohistan sequence. Workers in adjacent areas have found evidence that the MMT has southeast-directed transport of the Kohistan rocks over the Indo-Pakistan plate. In the study area that deformation has been overprinted by a ductile fabric that has top- to- the WSW sense of shear on a shallowly WSW-plunging stretching lineation. This ductile fabric is pervasive at the MMT contact, within the Indo-Pakistan plate cover sequence below the MMT, but decreases in intensity in the Indo-Pakistan plate basement rocks and the Nanga Parbat gneiss. If this ductile fabric represents normal fault movement then this deformation may have been responsible, in part, for the exhumation of the Nanga Parbat massif.

Key words: Deformation, Indian plate, MMT, Kohistan, Himalaya, Karakoram.

H/165. Hubbard, M.S. & Spencer, D., 1991. Top to the WSW displacement along the MMT, Babusar pass Nanga Parbat region, Pakistan. Abstract Volume, 6th Himalaya-Karakoram-Tibet workshop, Auris, France, 49.

The Himalaya/Karakoram mountains of northern Pakistan are the product of multiple deformational phases from continental collision events that trapped the Kohistan island arc between the Asian and Indian plates, to the development and emergence of the Nanga Parbat Syntaxis. Fieldwork along the Main Mantle Thrust (MMT) and within Indian plate rocks in the area between Babusar Pass and Toshe Gali was aimed at an understanding of the kinematics and temporal relationship between these deformational phases. The MMT is the suture between the Indian plate rocks and rocks of the Kohistan sequence. Workers in adjacent areas have found evidence that the MMT had southeast directed transport of the Kohistan rocks over the Indian plate. In the study area, that deformation has been overprinted by ductile fabric with a shallowly WSW-plunging stretching lunation. Quartz grain shapes, asymmetric augen, and shear bands suggest a top-to-the-WSW sense of shear. This ductile fabric is pervasive at the MMT contact, within the Indian plate cover sequence below the MMT, but decreases in intensity in the Indian plate basement rocks and the Nanga Parbat gneiss. This top-to-the WSW sense of shear represents normal, or extensional, shear relative to the Nanga Parbat massif. If there has been sufficient displacement across this zone then the WSW- trending deformational phase may have been responsible, in part, for the exhumation of the Nanga Parbat massif. Shallowly WSW-plunging stretching lineations have been reported in the adjacent areas to the northeast by Butler et al., 1989 and to the west by Greco, 1989.
Key words: Deformation, Asian plate, Indian plate, MMT, Kohistan.

H/166. Hubbard, M.S., Spencer, D.A. & West, D.P., 1995. Tectonic exhumation of the Nanga Parbat massif, northern Pakistan. Earth and Planetary Science Letters 133, 213-225.

Structural analysis in the Nanga Parbat region of northern Pakistan indicates that extensional deformation has been, in part, responsible for the exhumation of gneissic rocks of the Indian plate basement complex that dominates the Nanga Parbat massif. This massif has been mapped as a syntaxis at the boundary between the Indian and Asian plates in the northwest Himalaya and has received recent attention for evidence of rapid exhumation within the last 10 Ma. Field work along the Main Mantle Thrust (MMT) and within the Indian plate rocks in the area between Babusar Pass and Toshe Gali, southwest of the peak of Nanga Parbat, provided us with evidence from shear fabrics and a shallowly WSW-plunging stretching lineation for a dominant phase of extensional deformation. During this deformation rock of the Kohistan sequence and the Indian plate cover sequence moved to the WSW relative to rocks of the Indian plate basement including the Nanga Parbat gneiss. A post-metamorphic ductile shear fabric pervades the MMT contact, the Indian plate cover sequence below the MMT, but decreases in intensity in the Indian plate basement and the Nanga Parbat gneiss. Using39Ar/40Ar geochronology of hornblendes we have constrained the age of pre-deformational, amphibolite facies metamorphism to be ≤ 40–56 Ma. Published cooling ages from the Babusar Pass region further document that the extensional deformation was completed by ~20 Ma. We interpret this ductile, extensional shear as the mechanism responsible for significant tectonic exhumation of the gneissic and granitic rocks of the Nanga Parbat massif.
Key words: Tectonics, structure, exhumation, Nanga Parbat, Himalaya.

H/167. Hudleson, W.H., 1902. Fossils from the Hindu Kush. Geological Magazine, New Series, Decade 4, 9, 49-58.

Key words: Palaeontology, Hindukush.

H/168. Hughes, R.E., 1984. Yasin Valley: The analysis of geomorphology and building types. In: Miller, K. J. (Ed.), The International Karakoram Project 2, 253-288. Cambridge University Press.

The author's previous paper in these proceedings attempted to define a methodology for the study of building. This involves the examination of building construction, behavior and decay with all aspect being related to the environment.
A second theme showed that structural deformations and material decay if not remedied by "maintenance", "restoration" or "conservation" inevitably significance to the people than the less frequent, though more catastrophic, events such as earthquake and floods.

The intention of this paper is to show how the methodology was applied to the study of the Yasin Valley. It firstly concentrated on the geomorphology and relates to the inhabitants' awareness of, and response to, natural hazards. The buildings are then examined in detail: materials, construction, structural performance and decay. Methods for improving the houses are then discussed.
Of all the field studies undertaken by the author, this is considered the most important as there is a real and practical application, in conjunction with the UNDP development proposals, for benefiting the inhabitants.
Key words: Geomorphology, environment, disaster, floods, earthquakes, Yasin, Gilgit.

H/169. Humayun, M., 1985a. A rapakivi granite occurrence from Swat. Geological Bulletin, University of Peshawar 18, 198-199.

The Rapakivi granites of Swat are locally developed facies within large lensoidal bodies of biotite granites occurring in a mylonite zone at the base of the Swat granitic gneisses (Humayun, 1985). Large bodies occur just south-east of Manglaur and extending north of Dangram to Shamelai (Humayun, 1985, Fig. 1). They show intrusive relations with associated mafic rocks. The biotite granites have been tourmalinized in places. These appear to be the first known metamorphosed Rapakivi granites and the first reported occurrence from Pakistan.
The typical rapakivi texture consists of euhedral pinkish phenocrysts of orthoclase mantled by plagioclase. Unmantled ovoids and euhedral phenocrysts of orthoclase are also common. The biotite granites are apparently undeformed in the centre of a typical body, such as that at Shamelai, but show incipient metamorphism, mortar texture and recrystallization of biotite. On the contacts, however, the granites are mylonitized. A spectacular spotted gneiss results when a mylonite of rapakivi granite is seen in a section perpendicular to the lineation.
Key words: Rapakivi granite, Swat, Himalaya.

H/170. Humayun, M., 1985b. Tectonic significance of mylonites from Mingora, Swat. Geological Bulletin, University of Peshawar 18, 137-146.

Rocks below the Swat gneisses, formerly thought to be a single unit, are a varied assortment of thrust slices consisting of rapakivi granites, sillimanite gneisses, marbles, and schists, in a mylonite zone. This zone is interpreted as the base of a large thrust. Thus, the overlying Swat gneisses and associated schists constitute a crystalline thrust sheet or nappe (?), that probably formed in response to the obduction of the Kohistan island arc.
Key words: Tectonics, mylonite, Swat, Himalaya.

H/171. Humayun, M., 1986. Petrology of the Swat amphibolites and the development of a "lesser Himalayan" Basin. Geological Bulletin, University of Peshawar 19, 83-100.

A geochemical study of amphibolites from the lower Swat valley, Lesser Himalayas, identifies a suite of continental flood basalt erupted over a gneissic basement of probable Late Cambrian age. Fractionation of clinopyroxene and plagioclase controlled chemical variation in the protolith. Metamorphism, retrogression and granitic intrusion strongly affected the alkali and mobile trace element contents. The magmatism was probably associated with the early rifting stage of the development of Paleotethys. Subsidence of the rifted margin followed the extrusion of the basalt, and arkosic continental sediments gave way to marine carbonates and clastics. The carbonates belong to a reefoid association of Middle Paleozoic age. The basin extended over much of present-day northwestern Pakistan with probable analogues along the length of the Lesser Himalayas.
Key words: Petrology, amphibolite, Lesser Himalayan basin, Swat.

H/172. Humayun, M., Jan, M.Q. & Khan, M.J., 1987. A review of "Evidence of an incipient Paleozoic ocean in Kashmir, Pakistan" by K.A. Butt, M.N. Chaudhry & M. Ashraf. Kashmir Journal of Geology, 5, 121-126.

Geochemical data presented in the paper under review in shown to be erroneous. Severe overestimation of Al2O3 and underestimation of TiO2 and MnO, with evidently altered alkali and silica contents, render the analyses invalid for proposing a new tectonic model. The treatment does not prove the stated conclusion that the Punjal basalts are

MORB, and cannot even prove whether the rocks are tholeiitic, alkaline or otherwise. Finally, the rocks are claimed to be primitive, which we do not agree with.
Key words: Paleozoic, oceanic rocks, Panjal volcanic, tectonics, Kashmir.

H/173. Humayun, M., Mayeda, T.K., Clayton, R.N., Petterson, M.G. & Windley, B.F., 1991. Oxygen isotope study of the Kohistan Batholith. Abstracts, Fall Meeting, American Geophysical Union.

The Mesozoic Kohistan island arc of northern Pakistan represents a major addition of juvenile crust to the Asian landmass. The arc was formed at a convergent plate margin by northward subduction of the Neotethys ocean. The Kohistan sequence is unique in that it is tilted to expose a complete section through the crust of a fossil island arc. The Kohistan sequence comprises a lower crust of mafic amphibolites and mafic-ultramafic granulites. This is overlain by a mid-crustal batholith, an extension of the Trans-Himalayan batholith, which is intrusive in its upper reaches into greenschist grade metavolcanics and metasediments.
We present oxygen isotopic data on the Kohistan batholith with evidence regarding the nature of crustal differentiation in island arcs. Geochronological work shows the rocks of the batholith to have formed in three discrete phases of magmatism. Stage I: trondjhemites and K-rich diorites emplaced ca. 100 m.y., and subsequently metamorphosed; Stage II: gabbros, diorites and granodiorites emplaced 85-40 m.y., and constituting about two thirds of the batholith; Stage III: peraluminous leucogranites emplaced ca. 30 m.y., as minor dykes and veins. Diorites and granitoids from Stages I+II have 0180 = 6.7-7.7%0,anQ. Sr and Nd isotopic characteristics of mantle derived materials. We believe that these rocks tormea by partial melting of the juvenile arc crust in Kohistan, and that the Sr and Nd isotopic and trace element ratios are entirely inherited from the (subarc) mantle source. We consider the higher 0180 to be the result of a mixture of submarine weathered volcanic (+ sedimentary ?) material (0180 ""10%0) with a plutonic component (0180 = 6-6.5%0) in the lower crustal sources of the batholith, Such a source is conceivably found in the amphibolite belt underlying the batholith.
Stage III peraluminous Parri leucogranites pose something of an enigma. These rocks postdate collision of Kohistan with the Indian plate, and are mineralogically similar to and coeval with the Higher Himalayan leucogranites (HHL). Isotopic characteristics distinguish these rocks (initial $^{87}Sr/^{86}Sr$ = 0.7052 and 0180 = 8.4-9.2 %0) from HHL granites (initial $^{87}Sr/^{86}Sr$= 0.727-0.785 and 0180 = 10.9-14.0 %0). It is quite obvious that the Kohistan leucogranites formed by Kartial melting of arc crustal materials, too. The slightly higher initial $^{87}Sr/^{86}Sr$ (0.7052 VS. 0.7044) can be entirely accounted for by Rb decay during residence in the arc source (> 10 m.y.), while the higher 0180 may result from isotopic exchange between the fluid-rich leucogranite melts and country-rock metasediments.
The Kohistan batholith provides an excellent example of intra-crustal differentiation in island arcs, without the participation of pre-existing continental crust. Juvenile mafic crust is remelted during basaltic underplating of the lower crust to form granitic batholiths. Felsic crust made in island arcs is subsequently laterally accreted to the edges of continental plates, and can be incorporated in the interiors of continents by collisional events, as in the case of the Kohistan arc.
Key words: Kohistan batholith, geochemistry, isotopes.

H/174. Humayoon, S., 1976. Field report on the geology of Ayubia. M.Sc. Thesis, Punjab University, 90p.

Key words: Geology, Ayubia, Hazara.

H/175. Husain, V. & Bilqees, R., 1991. Developing Pakistan’s mineral resources and mineral industry. Proceedings, First SEGMITE Symposium, Peshawar, 17-26.

Key words: Mineral industry, Pakistan.

H/176. Husain, V., Bilqees, R. & Nasreen, S., 1989. Petrology and industrial application of Nizampur limestones, NWFP, Pakistan. Pakistan Journal of Scientific and Industrial Research 32, 11, 775-00.

Nizampur limestone samples have been studied for their petrology and geochemistry. The results of these studies indicate that Nizampur limestones are suitable for cement, chemical, paper and other industries.
Key words: Petrology, limestone, Nizampur, NWFP.

H/177. Husain, V., Ghani, A. & Qureshi, K., 1994. Vast export potential in dimension stone sector of Pakistan. Abstracts, Second SEGMITE International Conference on the Export Oriented Development of Mineral Resources and Mineral Based Industries, p.16.

In recent years there has been the development of a "New Stone Age" with the increasing use and production of dimensionstone. Its demand in the international market is increasing with an average of 6% per year. Another important development has been the rise in production and export from developing and newly industrialized countries. In 1990 India and China contributed 7.4% and 5.9% to the total world exports of dimensionstone respectively. This industry plays most important role in the economy of even rich and developed country like Italy, which has 25% share in total global exports of dimension stone.
Despite huge deposits of large varieties of marble, granite and other building stones occurring in Northern areas, North West Frontier, Sindh and Balochistan provinces of Pakistan, dimensionstone industry remains backward, unorganized and unprotected by the government. Thus the exports of mostly raw blocks and small manufactured items from Pakistan is only 30 million US$ per year, which can touch the mark of 3 billion US$ per year in next 5-7 years, provided following steps are taken on urgent basis. Due importance is given to the buildingstone mining and manufacturing industry by the government.
Making and implementing clear cut national dimensionstone policy to encourage modem mining and processing methods and to attract non-traditional and big local and foreign investment in this sector. Providing soft term loans and other facilities as India, China and Brazil have done to make export oriented development of dimensionstone industry in recent years.
Providing road, rail network and other infrastructure including supply of electricity and water in the marble granite mining and processing districts. Close coordination among dimensionstone related businessmen and professionals in Pakistan for organizing seminars and exhibitions in the country and abroad and to raise issues confronting the dimensionstone industry before local and federal governments.
Key words: Dimension stones, export potential.

H/178. Husain, V., Haneef, M., Khan, H. & Siddiqi, F., 1990. Barite deposition near Haripur, Hazara. In: Siddiqi, F., Husain, V., Kaifi, Z. & Ghani, A. (Eds.), Proceedings, First SEGMITE Conference on Industrial Minerals, March 1990, Peshawar, 22-28.

A barite district about 10 km north of Haripur occupies about 30 km^2 area. About a dozen vein deposits of barite occur in quartzites and dolomites. Regional analysis of this district suggests that barite occurs as veins and lenses in fractures and breccia zones. Field and laboratory evidence indicates that the barite deposits have good potential and are suitable for chemical paint and other industries. The occurrence is describes in detail, together with stratigraphy, and chemical analyses of six barite ores and five of their associated rocks
Key words: Barite, Haripur, Hazara.

H/179. Husain, V., Jan, N., Bilqees, R. & Ahmad, N., 1990. Petrology, mineralogy and origin of Hazara phosphates. In: Siddiqi, F., Husain, V., Kaifi, Z. & Ghani, A. (Eds.), Proceedings, First SEGMITE Conference on Industrial Minerals, March 1990, Peshawar, 45-52.

Sedimentary phosphate deposits of Hazara have proven reserves of over 8 million tons. The phosphatic beds occur in two horizons-cherty dolomite (Abbottabad Formation) and siltstones (Hazira Formation) of Early Cambrian age. Tectonic activity resulting in highly complex structural features have disrupted and segmented the deposits. Two distinct types of phosphorite are common in the area; very fine-grained phosphorite and ovel-shaped pellets. The deposits may have formed authegenically by direct precipitation of fine-grained mud (carbonate fluorapatite), which subsequently modified into pellets. Deposition seems to have taken place in shallow waters within low paleolatitudes like major phosphorite deposits of the world.

Key words: Mineral deposits, phosphate, Abbottabad

H/180. Husain, V., Jan, N. & Siddiqi, F., 1990. Mineralization of Kumhar magnesite, Hazara, NWFP. (short communication) Pakistan Journal of Scientific and Industrial Research 33(9), 325.

Key words: Mineralization, magnesite, Hazara.

H/181. Husain, V., Khan, H., Husain, M., & Bilqees, R., 1997. Composition, origin and economic potential of Kakul, Lagarban and Tarnawai Phosphorite deposits of Hazara, Pakistan. Pakistan Journal of Scientific and Industrial Research, 40(1–4), 6–40.

The carbonate fluorapatite, dolomite, calcite, quartz, hematite, magnetite, feldspar, kaolinite, montmorillonite and illite were important minerals identified by XRD and microscopy. Apatite mainly occurs as microsphorite and ovulitic or disc shaped pellets of variable size. The P2O5 content of these phosphorites range from 22 to 36% with major impurities of silica, magnesium, iron oxides, alumina and alkalies. All field and laboratory data generated on these phosphorites suggest that Hazara phosphorites were formed authigenically and underwent various phases of deformation, variable degree of weathering and recrystallization to produce pelletal or granular phosphorites.
Key words: Petrography, economic geology, phosphorites, Hazara.

H/182. Husain, V., Khan, H., Qureshi, K., Ahmad, N. & Ali, I., 1991. Mineralogical and analytical studies of the southwestern Tanol Barite District, Hazara, Pakistan. Pakistan Journal of Scientific and Industrial Research 34, 2-3, 65-00.

The Southwestern Tanol mineralized area north of Haripur is one of the most promising areas of barite deposits in NWFP. Several vein type barite deposits occur in Lower Cambrian quartz and dolomite of Abbottabad Formation. Barite veins have a direction that is parallel to the general trend to the host and associated rocks. Barite, quartz, calcite, feldspar, pyrite, illite and chlorite were identified by XRD and microscopy. Barite and quartz are predominant. Some textural features like the absence of primary bedding, coarse grain size of barite and cherty quartz with cross cutting relationships suggest an epigenetic origin. To date, Kag deposits have been mined by open pit method to 300 feet below the surface and the ore veins are expected to continue further deep. The mineralization occurs in lens shaped bodies having strike length of several hundred meters. The barite content of vein deposits range from 53-97% BaSO4 and impurities include quartz, calcite, dolomite, pyrite and limonite. The physical and chemical characteristics of the barite from this district suggest that these barites are suitable for drilling and chemical industries. They can also be used as filler in paint, plastic, paper and rubber industries.
Key words: Mineral deposits, Barite, Hazara.

H/183. Husain, V., Khan, H. & Siddiqi, F.A., 1990. Barite deposition in Haripur, Hazara. Abstracts, First SEGMITE Conference on Industrial Minerals, Peshawar, p.6.

Key words: Barite, sedimentary rocks, Haripur, Hazara.

H/184. Husain, V., Khan, M., Husain, M. & Siddiqi, F.A., 1994. Petrochemical and flotation studies of barite deposits near Haripur, NWFP, Pakistan. Sindh University, Research Journal 26, (1&2), 145-156.

The vein type barite deposits occur in Kag, Aluli and Darwaza near Haripur in NWFP. The coarse and interlocking grains of barite are hosted in quartzite and dolomite belonging to Abbottabad Formation. The barite is mostly whit to creamy, dark gray to brown in color. Barite textures vary systematically from coarse bladed to finely crystalline or massive. The specific gravity varies from 4.26 to 4.63. It contains 75-92% BaSo4. Quartz, calcite, dolomite, pyrite, goethite and hematite are the principal impurities.

The purpose of the present study is to describe Kag, Darwaza and Aluli barite deposits from the economic point of view. The description includes the petrological, mineralogical and chemical characteristics of the ore. The flotation studies have also been carried out on these barite samples and results have been discussed.
Key words: Petrochemistry, barite, Haripur, Hazara.

H/185. Husain, V., Khan, M.M. & Siddiqui, F.A., 1990. Vein type barite deposits in Kag, Alulai and Dawaza near Haripur, NWFP, Pakistan. Abstracts, 2nd Pakistan Geological Congress, University of Peshawar, 9-10.

Vein type barite deposits occur in Kag, Aluli and Darwaza near Haripur, NWFP. Coarse and interlocking of grains of barite are hosted in dolomite and quartzite of Tanawal Formation. The barite rock is mostly grayish white to snow-white and massive, having a specific gravity that averages about 4.0 and contains 65-98 percent $BaSO4$. Quartz, calcite, dolomite and iron oxide are the principal impurities. Preliminary flotation studies have indicated that quartz and other impurities can be removed from low-grade barites.
Key words: Barite, Tanawal formation, Hazara.

H/186. Husain, V., Sultan, S., Bilqees, R., Mateen, A. & Khan, B., 1993. Petrographic and geochemical studies of some phosphorite deposits of Hazara, Pakistan. Pakistan Journal of Scientific and Industrial Research 37, 6-7, 245-00.

Samples from Kakul mine and trenches of several phosphorite deposits were studied. These phosphorites occur in gradational contact with siltstone, dolomite and chert belonging to Abbottabad Cambrian System. Thinly bedded phosphorites occur mostly as pellets and microsphorite, while the intraclasts and pseudo-oolites are rare. Flourapatite is abundant in all the samples, while quartz, calcite, dolomite, feldspar, illite and hematite occur in minor phases. These phosphorites are primary marine formed mostly by direct precipitation. Recystallization is due to intense diagenesis, whereas ferruginization suggest weathering of phosphatic horizons in Hazara.
Key words: Petrography, geochemistry, phosphorites, Hazara.

H/187. Husnain, T. & Chaudhry, M.N. 1997. Strata-bound volcanic hosted gold, silver and sulphite mineralization occurrence in Paleocene-Eocene Dir volcanic group, District Dir, NWFP, Pakistan. Abstracts, National Symposium on Economic Geology of Pakistan, Islamabad, 2p.

Dir volcanic group which hosts Au. Ag and sulphide mineralization is composed of calc alkaline volcanic flows, tuffs, agglomerates and ignimbrites. The volcanic and volcanoclastic horizons are often intercalated with and are underlain by shallow marine meta-argillites and quartzites. Therefore, at least the lower part of the Dir volcanic group is submarine. Upper part was deposited under marine to sub areal conditions. The age of thig group is constrained by Eocene larger benthic Foraminifera which occur in the slightly metamorphosed marl and shales at the base of this group. Dir volcanic group represents the final stages in the magmatic/volcanic evolution of the Kohistan island arc terrain (Searle. 1991).
Although the Kohistan island arc itself was intra oceanic yet this volcanic group was laid down after the suturing of India with Asia sandwiching the Kohistan island arc. Therefore, these eruptions are in the nature of Andean type continental margin formed after the collision of Kohistan with Asia and closing of the Shyoke suture zone.
The rock which hosts gold. silver and copper anomalies occurs within the Dir volcanic group. The Dir volcanic group is composed of a lower Brawal Banda tuff and upper Utror volcanics. It represents the roof zone of the Kohistan batholith. One possible mechanism for mineralization is the late phase of southeast directed thrust sheets which cut the roof zone of the Kohistan batholith thus providing pathways to the hydrothermal copper rich fluids and strata bound mineralization in the Dir area. (Sulliman. 1989).
The geochemical studies of the mineralized zone show that Au varies from 3 to 11 ppm Ag varies from 6 to 200 ppm and Cu from 1% to 6.5%. The results are given in Table-1. Field observation and geochemical studies show that mineralization is strata bound type. Since the anomaly appears promising, therefore detailed studies should be carried out in the region to assess the potential of this mineralization.
Data analyzed on Atomic Absorption Spectrophotometer by Chemistry Division, GSP, Quetta.
Key words: Sulphide mineralization, gold, silver, Paleocene, Eocene, Dir volcanics.

H/188. Husnain, T., Khan, M.S., Hussain, K. & Chaudhry, M.N., 2000. Stratabound volcanic hosted gold, silver and suphide mineralization in Paleocene-Eocene Dir volcanic group, District Dir, NWFP, Pakistan. In: Hussain, S.S. & Akbar, H.D. (Eds.), Proceedings, National Symposium on Economic Geology of Pakistan, 1997, Islamabad, 83-88.

Consult the preceding account for further information.
Key words: Sulphide mineralization, gold, silver, Paleocene, Eocene, Dir volcanics.

H/189. Husnain, T. & Hussain, S.F., 1980. Geology and petrology of Naran–Saif–ul–Maluk area, Kaghan valley. M.Sc. Thesis, Punjab University.

Key words: Petrology, Naran, Himalaya.

H/190. Hussain, A., 1974a. Copper occurrence of Dir and Chitral district NWFP, Pakistan. Geological Survey of Pakistan, Information Release 73, 25p.

Key words: Mineralization, copper, Dir, Chitral.

H/191. Hussain, A., 1974b. Antimony, lead and zinc occurrences of Chitral District, North West Frontier Province, Pakistan. Geological Survey of Pakistan, Information Release 75, 31p.

An evaluation study of antimony, lead and zinc showings of Chitral district North West Frontier Province Was made during the field season of 1971-72. Numerous showings of economic significance occur in Kamal gol (Krinj), Awrit gol and Pakhturi areas. In Kamal gol area (Krinj) the antimony ore is emplaced into Chitral slate at and near its faulted contact with the marble of Reshun Formation. The ore is being mined from Kamal gol 2A mine; the other mines viz. Angargun and Kamal gol lA mines are closed since long. Probable reserves of 10,638 tons of ore has been estimated from Kamal gol 2A mine. In Awrit gol area, the high grade lead-antimony ore with some zinc is intermittently exposed for about 2000 feet along the faulted contact between the marble of Reshun Formation and phyllites of Kafristan-Partsan area. Probable reserves of 57,142 tons of ore has been estimated.
In Pakhturi area, a hillock of calcarious quartzite and sandstone is traversed by a network of nineteen quartz veins containing lead-zinc ore with some copper. Reserves of exposed ore are small but the wide distribution of mineralization indicates the possibility of larger deposits at depth. Geophysical survey and exploratory development work at Kamal gol, Awrit gol and Pakhturi areas are recommended.
Key words: Metallic minerals, Lead-Zinc, Chitral.

H/192. Hussain, A., 1975. Silica sand deposits of Khisore and Marwat Ranges, North West Frontier Province, Pakistan. Geological Survey of Pakistan, Information Release 91, 22p.

This report gives details of Silica sand deposits in Khisor and Marwat ranges, D.I.Khan. The deposits are at the base of the Datta formation, with an average length of 4.2 miles in Marwat Range and 3 miles in Khisore Range. The deposit with a little effort at beneficiation can be made used for making flint glass containers, table ware, sheet, rolled and polished glass.
Key words: Silica sand, Khisor-Marwat Range, D.I.Khan.

H/193. Hussain, A., 1976. Silica Sand Deposits of Munda Kachha Area, District Hazara, NWFP, Pakistan. Geological Survey of Pakistan, Information Release 95, 21p.

An evaluation study of Silica sand deposits of Munda Kuchha area, District Hazara, N.W.F.P. was conducted during the field season of 1972-73. The silica sand deposits are found in quartzose sandstone beds which is considered equivalent of Abbottabad Formation. The deposits occur in a broad syncline which extends from Sunda Gali to

Lugga Gali for a strike distance of four miles. The estimated reserves of silica sand upto a workable dip depth of 300 feet are found to be 57 million tons.
The average chemical analyses of' 22 channel samples from silica sand outcrops of Munda Kuchha area contain SiO_2 95.93%, Fe_20_3 0.61%, Al_20_3 1.26% CaO 0.52%, MgO 0.79%. The sieve analyses results indicate that a major portion of silica sand lies between -20 mesh to -120 mesh which is the required grain size for the manufacture of glass sand. The deposit with a little effort at beneficiation can be made usable in glass manufacture. The sand in the area fall in the 3rd, 5th, 7th and 9th category according to US Bureau of standard specification for glass sand and is suitable for the flint glass, green glass and amber glass.
Key words: Silica sand, Munda Kuchha, Hazara.

H/194. Hussain, A., 1978a. An interim report on high grade limestone deposits around Attock, Nizampur area, North West Frontier Province, Pakistan. Geological Survey of Pakistan, Information Release 100, 21p.

A study of high grade Limestone deposits of Attock-Nizampur area, NWFP, was carried out on the request of State Cement Corporation of Pakistan for setting up of a Cement plant. The limestone is exposed in the form of five isolated out crops which belong to Paleocene and Eocene ages. A reserve of about 930 million tons upto a workable dip depth of 200 feet in the area has been estimated.
The average chemical analyses of ten representative channel samples from the outcrops reveals CaO 51.34%, MgO 1.85%, SiO2 3.42%, Fe203 0.5%, Al2O3 0.94%, SO3 0.15% and L/ig. 40.96%. The limestone is suitable for the manufacture of Port land Cement and also suited for other industrial uses. The area is easily accessible and located close to rail and road links. This report is an interim document and will be followed by a more elaborate publication.
Key words: Limestone, Attock, Nizampur, NWFP.

H/195. Hussain, A., 1978b. Method for concentration of magnesite ore. Proceedings, National Seminar on Development of Mineral Resources, Lahore, 237-248.

Key words: Magnesite, minerals, ore.

H/196. Hussain, A., 1978-80. Electrical Resistivity Survey for ground-water exploration in Mardan Township Area, District Mardan, NWFP. M.Sc. Thesis, Punjab University, Lahore, 76p.

This report presents the results of ground-eater geoelectric investigations carried out in the Mardan Township area during the month of August, 1982, with the collaboration of Hydrological Directorate, WAPDA, Peshawar. The purpose of investigation was to collect the data to delineate the sub-surface geology of the area, and give some suitable sites for the installation of tubewells.
Mardan Township comprised an area of over 2 miles2. Total 23 resistivity probes were run in the area. The electrical resistivity measurements were made with Georesistivity meter using the schlumberger electrical configuration. The common depth of exploration at these resistivity stations was 600 meter. The electrical resistivity curves obtained in the filed were evaluates, interpreted and sub-surface geological cross-section based on true resistivity values were prepared to determine the vertical and horizontal extent of the sub-surface materials and aquifers.
Two-test hole upto a depth of two hundred feet were drilled and test wells were installed to determine hydrologic characteristics of the sub-surface sediments. The results of these studies indicate that within explored depth of 600 meters, the project area is under by sediments that consist dominantly of clay and silty clay. Beds of gravel and sand are present in the northwestern part of the project area extending further in the north-west. These beds of sand and gravel, constitute the aquifers in the subsurface, which may yield a fair supply of ground water discharge of these aquifers will be insufficient to meet the requirements of the area, which prohibits the installation of heavy duty tubewell in the project area.
Key words: Groundwater, hydrology, Mardan.

H/197. Hussain, A., 1984. Regional geological map of Nizampur covering parts of Peshawar, Mardan and Attock districts. Geological Survey of Pakistan Geological Map Series 142, 1:50,000.

Key words: Regional Geology, mapping, Nizampur, Peshawar, Mardan, Attock.

H/198. Hussain, A., 1985-87. The geology and petrography of Sharda-Kel area, Neelum valley (Azad Kashmir) with special emphasis on granites. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 96p.

A geological map of 80 Sq. Km, between Sharda-Kel area is presented at the scale of 1: 25,000 on toposheets Nos 43 J/5 and 43 J/1 issued by survey of Pakistan. Metasediments comprised of garnet mica schist, granite gneiss, amphibolites and migmatites which host small and large sheets of granites. Metamorphic rocks from Sharda to Kel area represent inverted sequence which is conformable to rocks south of MCT in occupied Kashmir. Petrographic analysis identifies deformation features which more likely are attributed to thrusting. Field and petrographic study of granites of the project area indicates that granites are S-type and are formed by high degree of partial melting of metasediments in catazone environments. Economic mineral deposits like marble, garnet and kyanite are identified.
Key words: Granite, petrography, maps, Neelum valley, Azad Kashmir.

H/199. Hussain, A., 1989. Geology of Dunga Gali-Barian Area District Abbottabad. M.Sc. Thesis, Punjab University, Lahore, 105p.

Geological and structural mapping of Kotili-Nikial-Khuiratta area of about 300 square km was carried on 1:50,000 scale of toposheet No's 43 K/2, 43 K/3, 43 G/11 and 43 G/15 of survey of Pakistan. The lithostratigraphic units described range in age from Pre-Cambrian to Pleistocene and consist mainly of sedimentary rocks. The Pre-Cambrian rock formation is Dogra Slate and Cambrian rock unit is Sirban Formation. In this area apart from Lower Cambrian, all the formations of Paleozoic and Mesozoic are missing. Either they were not deposited or were weathered to form Bauxite/Fireclay representing an unconformity of a big gap. In the Tertiary period, Patala Formation, Margala Hill Limestone, Murree Formation and rocks of Siwalik Group were deposited. Section measurements were done to establish the stratigraphy.
The rocks are folded and faulted comprising the major and minor structures of the area. The major folds of the area are khuiratta-Kohali anticline (11ρρ/325ρρ), Devigarh-Palana anticline (04ρρ/313ρ), Tattapani-Karela anticline (6ρρ/116ρρ) and Khad-Bahni syncline (6ρρ/228ρρ). The major fault is the Himalayan Frontal Thrust with minor thrust like Gala Thrust and Khad Thrust. Deformational events and stereographic projection of the area have been interpreted. The tectonic setup has been also discussed. About eighty five rock samples were taken from the field and carried back to the laboratory for petrographic studies. In the field of economic geology, a number of deposits including Fireclay, Bauxite, Coal, Limestone, Chalk and Dolomite are of economic interest.
Key words: Mapping, geology, Abbottabad.

H/200. Hussain, A., 1989-90. Geology and structure of Kotli-Nikial Khuiratta area with special emphasis on Himalayan Frontal Thrust and related structures. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 111p.

This report incorporates a comprehensive geological study of nearly 25 sq. km. area between Dunga Gali and Barian on the Murree-Abbottabad road. The study includes the preparation of a geological map on the scale 1:7040.
Stratigraphically the rock units range from Upper Jurassic to Eocene and represent the sequence of the Hazara Province of the Kohat-Potwar Basin. It is primarily a limestone-shale sequence reflecting a stable shelf facies. Structurally, the area shows the development of a few synclinoria and anticlinora, within which a generally tight parallel to similar asymmetric to overturn style of folding predominates. A number of dipslip-strike faults, both of the normal and reverse type are present. A petrographic study of all rock units, based on fairly representative field sampling, is also present.
Key words: Structure, Himalaya frontal thrust, Azad Kashmir.

H/201. Hussain, A., 1995. Cement raw material in the North West Frontier Province, Pakistan. Abstracts, International Symposium and Field Workshop on Phosphate and Other Industrial Minerals, Abbottabad, p.19.

Consult Hussain and Arbab, 1997.
Key words: Cement raw material, limestone.

H/202. Hussain, A., 1997-98. Geological mapping and hydrological studies of Rawalakot area (District Poonch) A.K., with special emphasis on quality of water. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 96p.

The pearl valley, investigated for water resources is present in the lesser Himalayas and exposed rock units are from Pre-Cambrian to Recent age. MBT and Pir Panjal thrusts are two main structural elements nearer to the area. The area under investigation is mostly in hilly regions. There were three main available sources of water, springs, streams and wells. The springs water and ground waters are polluted by organic, inorganic and biological contamination and by domestic and other wastes. Chemical and physical quality of water is at intermediate to high risk but microbiological and pollutant results showed that drinking water is at high risk. Chemically the quality of water is at low to high risk. The chemical constituents (Ca, Mg, Na, K, HCO3, CL, SO4, NO3, I, Fe, NO2 and F) indicate the water is at high risk. T.D.S, T.S.S and temperature enhance the growth of bacteria in water. The toxic metals in water cause diseases like kidney stone, liver stone, blood cancers, vomiting, abdominal problems and headache etc. It is concluded that the drinking water available from springs, streams and ground water are at intermediate to high risk.
Key words: Mapping, hydrology, geology, water quality, Rawlakot, Azad Kashmir.

H/203. Hussain, A., 2000. Cement raw materials and their requirements in the North West Frontier Province. In: Hussain, S.S. & Akbar, H.D. (Eds.), Proceedings, National Symposium on Economic Geology of Pakistan, 1997, Islamabad, 161-171.

Consult Hussain and Arbab, 1997.
Key words: Cement raw material, limestone.

H/204. Hussain, A., & Arbab, M.S.H., 1997. Cement raw materials and their requirements in the North West Frontier Province. Abstracts, National Symposium on Economic Geology of Pakistan, Islamabad, 1 p.

The main raw material components for cement production are limestone providing CaO and clay/shale/slate providing SiO2, Al2O3 and Fe2O3. When the set points for certain constituent are not met by using only two raw material components, then the additive admixtures which include Si-Carrier (sand), Al-Carrier (bauxite) and Fe-Carrier (laterite/iron ore) have to be added in the raw mix. The content of oxides in the cement are approximately as follows:-

Calcium oxide	(CaO)	62-68%
Silica	(SiO2)	2 1-24%
Alumina	(Al2O3)	4-8%
Ferric oxide	(Fe2O3)	2-5%

The North West Frontier Province is gifted with extensive deposits of suitable grade raw materials for the manufacture of Portland cement. The potential calcareous raw material comprises of Shekhai Limestone of Precambrian age, Samana Suk Limestone of Jurassic age and Lockhart Limestone of Eocene age. The argillaceous raw materials include Manki Slate of Precambrian age, Patala Shale of Paleocene age. Kuldana Shale of Eocene age and Lacustrine deposits of Quaternary age. The additive admixtures include iron ore and silica sand deposits of Data

Formation of Triassic age and the laterite deposits at the unconformable contact between the Cretaceous and Paleocene rock sequence.

The chemical analysis of the channel and core samples from these deposits show that all the elements are within permissible limits for the production of the Portland cement. The reserves of the raw materials are vast and several cement plants can be installed within Nowshera. Haripur. Kohat. Dera Ismail Khan and Federally Administrative Tribal Areas. Water, electric power. road links and other infrastructural facilities are also available in the areas. Cement is in considerable demand in Pakistan and there are also bright prospects for exporting cement to the neighbouring countries.

Key words: Cement raw material, limestone.

H/205. Hussain, A., Arbab, M.S.H. & Pogue, K.R. 1998. Stratigraphic and structural evolution of the Peshawar Basin, Pakistan. Regional Postgraduate Training Course in Plate Tectonics, Punjab University, 32-33.

The Peshawar intermontane basin is a broad, oval shaped and low-lying depression at the southern margin of the Himalayas (Pakistan). It lies to the north of the Attock-Cherat

Range and contains rocks transitional between the sedimentary fold- thrust belt to the south and a metamorphic terrane to the north.

The basin came into existence as the Kalachitta Range was faulted south on the Main Boundary Thrust (MBT) pushing the Siwalik foreland basin still farther south. The basin fill sediments predominently comprise of lacustrine, deltaic and fluvial deposits which are overlain by loess, flood-plain and alluvial-fan deposits of younger age. The study of the Landsat data, aerial photographs and subsequent field studies indicate a zone of late Quaternary deformation that extends across the southern margin of the Peshawar basin. Lacustrine, fluvial and alluvial-fan deposits that are dated at 2.8 to 0.6 Ma are tilted, folded and faulted along four left-stepping pressure ridges that extend for nearly 60 km.

Alluvial-fan and fluvial sediments are also folded and faulted at the Tarbela Dam and the base of the Indus River appears to be displaced by a reverse fault with its northwest side up. Additional small lineaments and faults occur parallel and oblique to the major fault structures. As a result of the present study, especially the finds of conodonts, the bed rock sequence co the Peshawar basin established previously, has been modified and revised. An almost complete sequence of rocks ranging from Precambrian to Triassic in age has been established for the first time in the Peshawar basin.

Key words: Stratigraphy, structure, Peshawar basin.

H/206. Hussain, A., Arbab, M.S.H., & Sadin, M., 2000. Geological Road Log along Islamabad-Peshawar-Khyber Pass. Islamabad-Peshawar Section. Geological Survey of Pakistan. Highways Geological Map Series, Map No. 3.

Key words: Maps, Islamabad, Khyber pass.

H/207. Hussain, A., Arbab, M.S.H. & Siddiqi, F.A., 1996. Prospects and potential for lightweight aggregates in Pakistan. Proceedings, Second SEGMITE International Conference on Export Oriented Development of Mineral Resources and Mineral Based Industries, Karachi, 1994, 18-22.

Consult Hussain, Siddiqi and Arbab, 1994.

Key words: Light weight aggregates.

H/208. Hussain, A., Chaudhri, M.A., Siddiqi, F.A. & Chughtai, M.Z., 1983. Lightweight aggregates; study of raw material in Pakistan, Islamabad and Peshawar region. Geological Survey of Pakistan, Records 66, 27p.

Key words: Light weight aggregates.

H/209. Hussain, A., DiPietro, J.A., & Haq, I., 1995. Geological Map of Choga quadrangle, (Toposheet No. 43 B/10, Scale 1:50,000), NWFP, Pakistan. New Geoscience No. 1107 (Old Sheet No. 72), Geological Survey of Pakistan. NWFP. Geological Map Series, III.

Key words: Geological map, Choga, Swat.

H/210. Hussain, A., DiPietro, J.A., & Pogue, K.R., 1997. Stratigraphy and structures of Peshawar Basin, Pakistan. Abstract volume, 2nd Nepal Geological Congress p.8.

Key words: Stratigraphy, structure, Peshawar basin.

H/211. Hussain, A., DiPietro, J.A. & Pogue, K.R., 1998. Stratigraphy and structure of the Peshawar Basin, Pakistan. Journal of the Nepal Geological Society 18, 25-35.

Key words: Stratigraphy, structure, Peshawar basin.

H/212. Hussain, A. & Karim, T., 1993. Mineral Map of NWFP. Geological Survey of Pakistan, Geological Map Series, Scale 1:1,000,000.

This report contains a map with showings, prospective deposits and productive deposits of metallic minerals, non-metallic minerals, fuel and energy minerals, and precious and semi precious stones. Also given are the locations, reserves, annual production and brief remarks. An inset map shows the location of the mineral based industries.
Key words: Maps, minerals, NWFP.

H/213. Hussain, A., Khan, R.N., Saeed, G. & Haq, I., 2002. Geologic map of Naushera District, NWFP, Pakistan. Geological survey of Pakistan (scale 1: 100,000).

Key words: Geologic map, Naushera

H/214. Hussain, A., Khan, S.R. & Saeed, G., 1990. A new look at the coal occurrence In Cherat area, N.W.F.P., Pakistan. In: Siddiqi, F., Husain, V., Kaifi, Z. & Ghani, A. (Eds.), Proceedings, First SEGMITE Conference on Industrial Minerals, March 1990, Peshawar, 34-37.

Small occurrences of coal deposits occur in Late Paleocene to Early Eocene Patala Formation in several places in the province. The Cherat coal, instead, occurs in the Early Paleocene Hangu Formation. The general stratigraphic setup of the Cherat Range comprises 1) Precambrian Dkhner Fm That is unconformably overlain by 2) Jurassic Samana Suk Fm, itself overlain by 3) Hangu Fm, 4) Paleocene Lockhart Limestone, Patala Fm, and unconformably overlying Early Miocene Murree Fm. Reserve estimates are not available, but the occurrence of coal in abandoned mine workings and boreholes suggest that its occurrence is widespread. The coal deposits of Aurakzai Agency and Makerwal are also located in the Hangu formation, raising the possibility of widespread occurrence of the coal of this age.
Key words: Coal, Hangu Formation, Cherat Range, Nowshera

H/215. Hussain, A., Pogue, K.R. & Arbab, M.S.H., 1992. Stratigraphy of the Himalayan foothills of northwest Pakistan. Abstracts, First South Asia Geological Congress, Islamabad, p.16.

Key words: Stratigraphy, Himalaya foothills.

H/216. Hussain, A., Pogue, K.R., & DiPietro, J.A., 1988. Paleozoic stratigraphy of the Peshawar Basin, Pakistan. Geological Society of America, Abstracts 20, 266–267.

Key words: Stratigraphy, Paleozoic, Peshawar basin.

H/217. Hussain, A., Pogue, K.R. & DiPietro, J.A., 1995. Stratigraphy and tectonics south of Main Mantle Thrust, Peshawar Basin, Pakistan. Abstracts, International Symposium on Himalayan Suture Zone of Pakistan. Pakistan Museum of Natural History, Islamabad, 17-18.

Key words: Stratigraphy, Tectonics, MMT.

H/218. Hussain, A., Pogue, K.R. & DiPietro, J.A., 1998. Stratigraphic and structural framework of the Himalayan foothills between Panjal-Khairabad thrust and MMT, Peshawar Basin, Northern, Pakistan. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop, p.82.

The Panjal-Khairabad Thrust form the boundary between the Lesser Himalayan and Tethyan section, a function performed by the Main Central Thrust (MCT) in the Central Himalaya of India and Nepal. All pre-Cenozoic rocks north of the Panjal-Khairabad Thrust have been metamorphosed. The metamorphism increases from south to north from greenschist to kayanite grade. An almost complete sequence of rocks ranging from Precambrian to Jurassic age has been established for the first time in the area. The Proterozoic rocks represented by Gandaf Formation and Manki Formation with associated carbonate form the base of the stratigraphic section. These rocks are overlain by Precambrian and Cambrian Tanawal Formation; Cambrian (?) Ambar; Ordovician Misri Banda; Llandoverian to Pridolian Panjpir Formation, Lochkovian to Frasnian Nowshera Formation and Kinderhookian to Westphalian Jafar Kandao Formation. The Karapa Greenschist, consisting of metamorphosed lava flows separate the Jafar Kandao from Upper Triassic (Carnian) marble of Kashala Formation. The upper Triassic and Jurassic (?) Nikanani Ghar Formation forms the top of the section.

Correlatives to the stratigraphic setup of the Peshawar Basin are present in the Khyber-Mohmand to the west and Hazara to the east. The sequence contrasts markedly with the Paleozoic and Mesozoic sequence exposed to the south of Panjal-Khairabad Thrust. The newly - dated Carboniferous to Triassic rocks provide age constrains on the high-grade metasediments of Swat exposed to the south of MMT. The dating has also provided age constrains on pre-Himalayan tectonism and intrusions. The stratigraphic information combined with geochemical analyses and radiometric dates on the igneous rocks of the area permits the recognition of a major phase of Paleozoic rifting in the Peshawar Basin.

Key words: Stratigraphy, structure, tectonics, MCT, MMT.

H/219. Hussain, A., Pogue, K.R. & DiPietro, J.A., 1999. Paleozoic stratigraphy of the Himalayan foothills of northern Pakistan: Correlation and implications. Additional abstracts, IGCP 421 (North Gondwanan mid-Palaeozoic Bioevent/Biogeography Pattern in Relation to Crustal Dynamics), Peshawar Meeting, 1p.

Key words: Stratigraphy, Paleozoic, Himalayan foothills.

H/220. Hussain, A., Pogue, K.R. & DiPietro, J.A., 2001. Stratigraphy of the Precambrian rocks of the northwest Himalaya, Pakistan. Abstracts, 4th Pakistan Geological Congress, Islamabad, p.28.

The Precambrian rocks of the northwest Himalaya, Pakistan consists of Proterozoic and Archean (?) crystalline basement rocks overlain by a Proterozoic sedimentary and metasedimentary cover sequence. The effect of regional metamorphism increases gradually from south to north. South of the Main Boundary Thrust (MBT) Upper Proterozoic evaporites (the Salt Range Formation) unconformably overlie Proterozoic metamorphic and igneous

complex exposed in the Kirana Hills of Sargodha, Chiniot and Sangla areas (Gee, 1989). Between the MET and the Panjal-Khairabad thrust (PKT), the Proterozoic sedimentary cover is represented by sandstone, argillite, slate, and limestone of the Dakhner Formation in Attock-Cherat Range and its eastern equivalent the Hazara Formation in Hazara. Gypsum intervals in the Hazara Formation imply that the Hazara and Salt Range Formations may be lateral equivalents. Between the PKT and Darband Fault, the oldest exposed Precambrian rocks are slate and phyllite of the Manki Formation, which are interpreted as the metamorphosed equivalent of the Hazara/Dakhner Formation. The Manki Formation is overlain by limestone and argillite of the Shahkot, Utch Khattak, and Shekhai Formations. These limestones thin northward to be replaced by quartzite and argillite of the Tanawal Formation. Near Tarbela Lake, the Tanawal Formation overlies marble and graphitic schist of the Gandaf Formation, which is interpreted as a higher-grade equivalent of the Manki Formation. The Gandaf Formation thickens northward in the Indus syntaxis and unconformably overlies graphite-muscovite plagioclase schist and tremolite marble of Karora Formation of Proterozoic age. The metaconglomerate is found at the base of Karora Formation where it unconformably overlies small outcrop of quartzo-feldspathic rock, gneiss, and quartzite of Kishar Formation of Early Proterozoic age.
The entire Precambrian sequence around Tarbela Lake is extensively intruded by Cambrian granodiorite (the Mansehra and Swat Granites), Late Paleozoic alkaline granitoids (the Ambela intrusive complex), and Permian mafic dikes and sills. In the Indus Syntaxis north of Tarbela there is evidence of plutonism of Early and Late Proterozoic age by the granodiorite gneiss, orthogneiss and leucogneiss of Besham Complex, orthogneiss of Kotala Complex and biotite orthogneiss and migmatite of Black Mountain Complex.
Key words: Stratigraphy, Precambrian, metasediments, Himalaya.

H/221. Hussain, A., Pogue, K., Khan, S.R. & Ahmad, I. 1990. Palaeozoic stratigraphy of the Peshawar basin, Pakistan. Abstracts, 2nd Pakistan Geological Congress, University of Peshawar, p.35.

Consult the following account.
Key words: Stratigraphy, Paleozoic, Peshawar basin.

H/222. Hussain, A., Pogue, K.R., Khan, S.R. & Ahmad, I. 1991. Paleozoic stratigraphy of the Peshawar basin, Pakistan. Geological Bulletin, University of Peshawar 24, 85-97.

An almost complete Paleozoic sequence of sedimentary rocks is exposed in the ranges fringing the Peshawar basin. The present study establishes a revised stratigraphy and modifies the stratigraphic nomenclature of the previous workers. The Pre-Cambrian – Cambrian Tanawal Formation forms the base of the sequence and is overlain unconformably by the Ambar Formation (Cambrian?). The Misri Banda Quartzite unconformably overlies the Ambar Formation and contains Cruziana ichnofossils, which indicate an Early to Middle Ordovician age. The limestone at the base of the Panjpir Formation contains siluricus zone conodonts (Ludlovian) and unconformably overlies the Misri Banda Formation. The Early to late Devonian Nowshera Formation overlies the Panjpir and contains a reef facies first recognized by Stauffer in 1968. The youngest recognized Paleozoic unit is the Jafar Kandoa Formation from which Carboniferous conodonts have been obtained. The section outlined above has possible correlatives in the Khyber and Hazara regions, but differs dramatically from the Paleozoic sequence of the Salt Range to the south. The tectonic setting of the area is transitional between a sedimentary fold belt to the south and a metamorphic terrane to the north.
Key words: Stratigraphy, Paleozoic, Peshawar basin.

H/223. Hussain, A., Siddiqui, F.A. & Arbab, M.S.H., 1994. Prospect and potential of the light weight aggregates in Pakistan. Abstracts, Second SEGMITE International Conference on the Export Oriented Development of Mineral Resources and Mineral Based Industries, p.19.

Lightweight concrete aggregates are expanded rock material weighing less than the conventionally used aggregates of sand, gravel and crushed stone. These aggregates are produced from natural deposits of pumice, scoria, volcanic cinder, tuff and diatomite; by industrial cinder; and by the application of heat to expand clay, shale, slate, diatomiceous shale, perlite, obsidian and vermiculite. In Pakistan workable occurrences of these material except for clay, shale and slate are either non-existant, at present, or are found in such remote regions that the cost of their mining and transportation to the consuming centres, is prohibitive.

Bloatable argillaceous raw material suitable for use in the making of lightweight aggregate has been proved to exist in large quantities in the region between Islamabad and Peshawar. This raw material comprising of Eocene shale and Precambrian slate is exposed in parts of the Margalla and the Attock-Cherat Ranges respectively. Low cost open pit mining can be applied for its extraction. Field and laboratory studies conducted jointly by the GSP and the Pakistan Council of Scientific and Industrial Research have established that the unit weight and compressive strength of the cubes (test) made from this material (expanded compares well with the ASTM specification for the structural concrete).

The clay deposits are widely found in the country but most of these attain the desired level of bloating only after the addition of organic matter. This raises the production cost and often creates processing problems.

Investigations in other parts of the country for lightweight aggregates are planned to be undertaken in the near future.

Key words: Light weight aggregates, sand, gravel.

H/224. Hussain A., Turi, A.A. & Haq, I., 1995. Geological map of Mazri Tang (38 O/7). Geological Survey of Pakistan.

Key words: Geological map, Mazri Tang.

H/225. Hussain, A., & Yeats, R.S., 1991. Geology and tectonics of the Attock-Cherat Range and southern Peshawar Basin, Pakistan. Abstracts, 1st Postgraduate Training Course in Plate Tectonics, Punjab University, Lahore, p.4.

Key words: Maps, Attock-Cherat, NWFP.

H/226. Hussain, A., & Yeats, R.S., 2000. Geology and tectonics of the Himalayan foothills of Northern Pakistan. Abstracts, Third South Asia Geological Congress, Lahore, 3-4.

Key words: Tectonics, Himalayan foothills.

H/227. Hussain, A., Yeats, R.S. & Pogue, K., 1989a. Stratigraphy and structural events around the southern margin of Peshawar basin, Pakistan. Geological Bulletin, University of Peshawar 22, 45-54.

The Peshawar intermontane basin is superimposed on the fold-thrust belt at the southern margin of the Pakistan Himalayas. In the southern part of the basin the first Ordovician rocks were identified near Nowshera on the basis of discovery of trilobite trace fossils and consequently the Paleozoic stratigraphy of the area has been revised and modified. The Attock-Cherat Range forms the southern boundary of the Peshawar basin and includes rocks transitional between metasediments of Lesser Himalayas and foreland basin strata of Kala Chitta Range to the south. The range is dominated by slate, less metamorphosed argillaceous and arenaceous strata and subordinate limestone of Precambrian to Paleozoic age. These rocks are unconformably overlain by a thin cover of Jurassic, Cretaceous (?), Paleocene, Eocene and Miocene rocks. The structural events close to the Peshawar basin are recognized in pre-Paleocene, pre-Pliocene and late Quaternary times. The Peshawar basin formed as the Kala Chitta Range was faulted south on the Main Boundary Thrust (MBT) pushing the Siwalik foreland basin still further south. Evidence for active tectonics is found in four left-stepping en-echelon pressure ridges formed within Peshawar basin parallel to its southern margin.

Key words: Stratigraphy, structure, Peshawar basin.

H/228. Hussain, A., Yeats, R.S., & Pogue, K.R., 1989b. Geological Map of Attock–Cherat Range and adjoining areas, NWFP, and Punjab Pakistan (Scale 1:100,000). Geological Survey of Pakistan. NWFP Map Series, vol. III.

Key words: Maps, Attock-Cherat, NWFP.

H/229. Hussain, A., Yeats, R.S. & Pogue, K., 1990. Geologic map of Attock-Cherat Range and adjoin areas of NWFP and Punjab. Geological Survey of Pakistan (scale 1: 100,000).

Key words: Geological map, Attock-Cherat Range

H/230. Hussain, A., Yeats, R.S. & Shah, R., 1997. Geology of the Himalayan foothills from the perspective of the Attock-Cherat Range; Correlations and implications. Abstracts, 3rd Pakistan Geological Congress, University of Peshawar, p.18.

Key words: Stratigraphy, structure, Attock-Cherat, Himalayan foothills.

H/231. Hussain, B.R., 1966. Oil in Pakistan, an evaluation. The Geologist, Karachi, University, 75-78.

Key words: Hydrocarbons.

H/232. Hussain, B.R., 1967. Saidwali member, a name for the lower part of the Permian Amb Formation, West Pakistan. University Studies (Karachi), Science & Technology 4(3), 88-95.

Key words: Amb Formation, Saidwali member, Permian.

H/233. Hussain, B.R., 1969. Mianwali Group Redefined. Geological Bulletin, University of Peshawar 4, 14-17.

Mianwali, if at all retained in the nomenclature, must be restricted to a group name only.
The 'Mianwali Group' should embrace only the Mittiwali and Narmia Formations and the Kathwai Dolomite Member be assigned to the lower part of the Mittiwali Formation. Landa and Khatkiara may be assigned separate formational status and if necessary, be included under the Tredian Group which may then be defined according to the notes and letter of Dr. Geo on this subject.
Key words: Stratigraphy, Mianwali group.

H/234. Hussain, F., Bhatti, N.A. & Sethi, U.B., 1990. Geologic map of Attock area, Punjab and NWFP, Pakistan. US Geological Survey, Geological Map Series. Scale 1:250,000.

Key words: Mapping, Attock-Cherat, Punjab, NWFP.

H/235. Hussain, I., 1990-92. Sedimentology of Middle Jurassic Samana Suk Formation, District Abbottabad, Pakistan. M.Sc. Thesis, Punjab University, Lahore, 186p.

The Samana Suk Formation is a part of Mesozoic sequence, starting from Early Jurassic Datta Formation to Upper Cretaceous Kawagarh Formation. This sequence is interrupted by one break in deposition.
The sedimentology of Samana Suk Formation exposed at Sikhar ridge (Sangar Gali) and Thai Barrier (near Abbottabad) is based upon thorough section measurements, collection of more than three hundred samples followed by extensive laboratory work. The Samana Suk Formation represents five shallowing upward cycles. Every cycle is topped by hard ground surface on ooidal grainstone. The sediments have been subjected to various diagenetic events, out of which dolomitization is significant phenomenon. At least two phases of dolomitization have been determined. The zonation in the dolomite crystals not only represents the pore water chemistry but also varied

environments of formation. Dedolomitization has led to the development of porous horizons. The third order sea level curves based upon microfacies assemblage and diagenetic events generally match with P.R. Vail's curves.
Key words: Sedimentology, Samana Suk Formation, Datta Formation, Mesozoic, Jurassic, Abbottabad.

H/236. Hussain, I., Mahmood, A. & Ali, Z., 1974. Field report on eastern Chamla and Khadukhel, Lower Swat. M.Sc. Thesis. Punjab University, Lahore.

Key words: Petrology, Buner, Swat.

H/237. Hussain, K., Sultana, I. & Sheikh, N., 1983. Beneficiation of Malakand graphite on pilot plant scale. Second National Seminar on Development of Mineral Resources, Peshawar, 3, 6p.

Key words: Graphite, beneficiation, Malakand.

H/238. Hussain, M., 1972. Thesis on geology of Dir - Bibior area, District Dir, with special emphasis on Amphibolite and Calcareous Quartzite. M.Sc. Thesis, Punjab University, Lahore.

Key words: Amphibolite, calcareous quartz, petrography, Dir.

H/239. Hussain, M., 1981-83. Geology and petrology of Darel valley (District Diamer) with special emphasis on the petrology of diorites and amphibolites of the area. M.Sc. Thesis, Punjab University, Lahore, 65p.

This thesis presents a geological map of the 30 sq .miles of project area (DAREL) on scale 1" = 1 mile. The project area (Darel) lies in Gilgit Agency, district Diamer. The area is located in the centre of Kohistan. Area is disturbed tectonically, being involved in Himalayan orogeny. The area is composed of igneous and metamorphic rocks. The main rock units in the area are Norite, Diorite, Amphibolites and Granodiorites. Mineralogical description and petrographic analysis of these rock units are reported in detail. An attempt is made to interpret the petrogenesis of rock types. The Thesis presents a detailed geological and petrological investigation of the project area. Norite and amphibolites represent oceanic crust while Diorite and Granodiorite etc. represent plutonic equivalents of arc. To achieve this goal a period of 45 days was spent at the site during July, August 1984.
Key words: Petrology, diorite, amphibolite, Diamir.

H/240. Hussain, M., 1988. Report on Geology and Structure of Balakot-Kummi Area. M.Sc. Thesis, Punjab University, Lahore, 100p.

The present work constitutes a comprehensive report on the geology of Balakot-Kummi area and is submitted in partial fulfillment of the requirements for the degree of M.Sc. at the University of Punjab. The report includes a detailed geological map at 1:6,000 of about 65-km2-area alongwith a number of geological sections and sketches. The various chapters include geomorphology, stratigraphy, structure and tectonics. Stratigraphically, the Balakot-Kummi area includes a number of diverse sedimentary and metamorphic elements ranging in age from Precambrian to Miocene with a fairly large gap in the Mesozoic period. Structurally, the area incorporates part of the core and western limb of the Hazara-Kashmir syntaxis and through it pass the major Murree and Panjal Faults. The Balakot-Muzaffarabad anticline is the major fold overturned and overthrust to the southwest. No major economic mineral deposit was found within the project area, although a lot of material is available as rock crush, aggregate components and building stones.
Key words: Mapping, structure, sedimentary rocks, metamorphic, Precambrian, Miocene, Balakot, Hazara.

H/241. Hussain, M., 1990-92. Geology and structure of Changla Gali Area, District Abbottabad. M.Sc. Thesis, Punjab University, Lahore, 170p.

Large-scale (1:7000) geologic mapping of a small segment of the Lesser Himalaya in the Chhangla Gali area is presented. A Jurassic to Eocene succession mainly comprising shallow shelf carbonates, with an important unconformity at the Cretaceous-Tertiary boundary, is part of the southern Hazara sedimentary province. A petrographic microfacies study of measured sections of Lockhart limestone reveals that the formation comprises 31 microfacies of mudstone, wackestone and packstone. Structurally the area comprises NE-SW trending double plunging folds constituting anticlinoria and synclinoria. The folds are tight to isoclinal with a general vergence to the southeast. The folded sequence is disrupted by a number of high angle dip-slip strike faults especially within or on the margins of anticlinoria.
Key words: Structure, petrography, Jurassic, Eocene, Abbottabad.

H/242. Hussain, M., Rashid, M.A., Sethi, U.P. & Meisner, C.R., 1967. Geology of the Parachinar quadrangle, West Pakistan. Geological Survey of Pakistan and U.S.G.S., Project Report, PK (IR)–28, 75p.

Key words: Geology, mapping, Parachinar.

H/243. Hussain, M. & Siddiqi, R.A., 1993. Phosphorite prospecting in Nizampur area, District Peshawar, NWFP. Geological Survey of Pakistan, Information Release 539.

Geological and geochemical investigations were conducted in Nizampur area, district Peshawar, NWFP, for the phosphorite prospecting. Rock units exposed in the area belong to the formations ranging in age from early Triassic to recent deposits. Field and camp chemical tests were conducted for P_20_5 content in the samples collected from the outcrops. Detailed analyses were also done of few selected samples from different formations.
The work concluded that two formations i.e, Chichali formation (early Cretaceous to late Triassic) and Lumshiwal formation (early Cretaceous) have Phosphatic nodules which contain upto 27% and 28% P_20_5 respectively. The size and percentage of these nodules are varying whereas the matrix is mostly devoid of P_20_5 content. There is no economic significance of these phosphatic rocks. However the green sand part of the Lumshiwal formation which has 1-2% P_20_5 and quite friable can directly be applied in the fields to give better crops. Green sand has also been used as potassic fertilizer and water softener in different parts of the world. It was observed that crops growing on green sand bearing area, were looking better and reportedly giving better yield in comparison to the one's on the other rock units.
Key words: Geochemical prospecting, phosphorite, Nizampur, Peshawar.

H/244. Hussain, M.A., 1997. Sustainable groundwater development, Lei-Basin (Islamabad-Rawalpindi), as an example of groundwater recharge, prospects for arid and semi-arid countries. Abstracts, 3rd Pakistan Geological Congress, University of Peshawar, 19-20.

Key words: Groundwater, sustainability, Islamabad.

H/245. Hussain, M.I., 1961. Engineering geology and some pertinent problems at the Warsak dam site. Abstract volume 13th All Pakistan Science Conference Dacca, p.7.

Key words: Dams, engineering geology, Warsak.

H/246. Hussain, M.S., 1990-91. The geology and stratigraphy/micropaleontology of Bagla, Khala-Bala Area District Haripur, Hazara (NWFP) Pakistan. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 103p.

Patala Formation having khaki Shales with fossiliferous limestone bands. The environment is shallow marine, (Circa litoral sub-zone). Margala Hill Limestone is fossiliferrous, nodular limestone. It shows deep sea depositional environment. Chorgali Formation consists of limestone with marl, having abundance of fossils. It shows shelf

environment. Kuldana Formation mainly has shale, marl and sandstone with gypsiferrous bands. The Formation was deposited in shallow marine oxidizing conditions. The climate was hot and arid and the rate of evaporation was high. The thin section slides from Jurassic to Eocene rock units have been studied. Petrographically Lockhart Limestone (Paleocene) and Margala Hill Limestone (Eocene) have been studied in detail. According to Folk's (l962) classification, Lockhart Limestone is normally Wacke to pack stone while according to Dunham's (1962) it is fossiliferous to packed biomicrite. Margala Hill Limestone is mainly wacke stone, mud stone and packstone (Folk's) and it is biomicrite, biosparite and biosparry micrite (Dunllam's). The measured stratigraphic sections of the rock units from Jurassic to Eocene are presented in Lithologs No 1 to 4 (Pocket). Tectonically the area is highly disturbed, being involved in Himalayan Orogeny. Geological sub surface structures are described with the help of cross section. Almost all the major structures follow the general trend NE-SW. From the cross-section line along AA' shows that there is intrusive deformation in the area. Some important folds are Hili-Bagla anticline, Seri and Kuhmal synclines. The project area is highly faulted. The major faults Malat Thrust fault and Kohala-Darkot Thrust fault running parallel to sub parallel following general trend. These faults are reverse and thrust steeply dipping to SE. The Economic potential of limestone of various rock units, Laterite and aggregates have been
Key words: Stratigraphy, micropaleontology, Haripur, Hazara.

H/247. Hussain, M.S. & Ahmad, S., 1969. A study of analcime mineral in some soils of West Pakistan. Pakistan Journal of Scientific and Industrial Research 12, 34-36.

Three out of a total of nine soil samples from West Pakistan showed unusually high (more than 100) exchangeable sodium percentage (ESP) when determined according to the conventional methods. But the pH of these soils ranged from 7.0 to 7.6. This was regarded as an unusual result. It was suspected that the high ESP in the soils may be due to "zeolitic sodium" released from analcime mineral. An intensive mineralogical investigation showed that there is no analcime mineral present in these soils. The high ESP in the soils was therefore not caused by analcime mineral. Low pH values (7.0-7.6) might be regarded as the main obstacle in the way of the synthesis of analcime in the soils under study.
Key words: Soil, West Pakistan.

H/248. Hussain, M.T. & Aslam, M., 1974. Reconnaissance geology of Indus Valley road, Pakistan. Geological Survey of Pakistan, Information Release 78.

This report gives an account of the road side geology from the area between Thakot and Chilas. It gives some minor details of the geology around Thakot, Duber, Patan and Kyal. It contains four maps.
Key words: Mapping, Indus valley road, Thakot, Chilas.

H/249. Hussain, N. & Rehman, S., 1980. The general geology and the structure of the area between Khairabad and southern abutment of Attock bridge. M.Sc. Thesis, Peshawar University.

Key words: Structure, Attock-Cherat, Attock.

H/250. Hussain, R.I., 1985-87. Geology and structure of Doarian Khojaseri area Neelum valley District Muzaffarabad Azad Kashmir with special emphasis on metamorphic tectonics. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 56p.

About 130 sq. km Doarian, Dudhnial, Khoja-Seri area a part of Neelum valley (Azad Kashmir) has been mapped at a scale of 1:50,000. The area is characterized by high relief and v-shaped valleys. The rocks of the area are metamorphic of lower Pre-Cambrian, injected by later intrusions of igneous bodies, granites with some basic. Regional metamorphism and accompanying penetrative deformation post-dates the granite intrusions, because the granite itself is involved in the deformation. Field evidences and laboratory studies favour magnetic origin for the granitic bodies. The area is tectonically highly disturbed being involved in Himalayan orogeny. For petrographic analysis thirty thin sections were studied. Petrogenesis of the rocks of the area is interpreted. Major and minor structures of the area are described. Geological history of the Project area is worked out in comparison with adjoining areas of Punjab Himalayas and northern peninsular India. Economic minerals found in the area are listed.

Key words: Tectonics, structure, metamorphism, Muzaffarabad, Azad Kashmir.

H/251. Hussain, S., 1983-85. Biostratigraphy of the Jhalar Area-the Kala Chitta Range, Attock District. M.Sc. Thesis, Punjab University, Lahore, 90p.

A geological map of the Jhalar area-the Kala Chitta Range, on a scale of 1" to 0.789 mile or 1:50,000 and covering an area of 16.43 miles2 has been prepared to discuss the stratigraphy and micropaleontology of the area. An attempt has been made to discuss the importance of foraminifera content of these rock units, for determining the depositional pattern and age. The geological sequence of the Kala Chitta Range with a view to recognize the continuity or unique aspects of the lithostratigraphic units in the adjoining area. The various geological events that occur in the area and their geological implications have also been discussed. In the Kala Chitta Range there are some eighteen lithostratigraphic units but the area under discussion comprises ten lithostratigraphic units mostly of marine environments and with non-marine units.
Key words: Stratigraphy, micropalaeontology, Foraminifera, Kala Chitta, Attock.

H/252. Hussain, S., 1999-2000. Geological mapping of Kohala-Muzaffarabad area with special emphasis on slope stability problems identification analysis & remediation along Kohala Muzaffarabad Road Azad Kashmir. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 75p.

Gullian, Dulai and Rara is an area of high landslides hazards. The landslides are at the right bank of the River Jhelum, characterized by high and narrow divides separated by steep tributaries cut into bedrock. The rocks are highly fractured and jointed with steep dipping slopes agitated by (MBT) and pore water pressure. The abundance of clays and silty soils and humid climatic condition of the area contribute to landsliding in Muzaffarabad region. The situation is aggravated by cutting for road widening and destabilization of slopes by earthquakes resulting in major landslides. Rock fall, rock topple shear failure. Earthflow, slumps and combination of these are most common modes of failure. Gullian (1-2)) Dulai and Rara landslides were investigated in detail because of the proximity to roadways. Topographic and geological maps were prepared for each soil and soil samples were collected to establish engineering properties and stratigraphic succession involved in failure. It has been concluded that the slope failure is mainly in the areas where Murree clays are involved. The swelling potential of Murree clays, pore water pressure, Main Boundary Thrust (MBT) and uneven drainage also contribute to landsliding. It is suggested that the improvement of drainage pattern calculation of overburden material, pore water pressure and after the consideration of seismic loads retaining walls should be constructed. At places piling is also necessary.
Key words: Mapping, slope stability, Muzaffarabad, Azad Kashmir.

H/253. Hussain, S.M., 1957. Salt Range, Potwar, Murree, Abbottabad and Swat. M.Sc. Thesis, Punjab University, Lahore.

Key words: Mapping, stratigraphy, Salt range, Potwar.

H/254. Hussain, S.S. & Akbar, H.D. (Eds.), 2000. Economic Geology of Pakistan. Proceedings, National Symposium on Economic Geology of Pakistan, 1997, Islamabad. Pakistan Museum of Natural History, Islamabad, 302p.

This is a compilation of paper presented in 1997 Conference. Thirteen of the 18 papers are summarized at appropriate places. The papers have been distributed into five sections: I Metallic Minerals, II Industrial Minerals, III Energy Resources, IV Geological Materials/Geohydrology, and V Gemstones. These are followed by general recommendation.
Key words: Economic geology.

H/255. Hussain, S.S., Chaudhry, M.N. & Dawood, H., 1992. Emerald mineralization of Barang, Bajaur Agency, Pakistan. Abstracts, First South Asia Geological Congress, Islamabad, p.57.

Consult the following account.
Key words: Emerald, gemstone, mineralization, Bajaur.

H/256. Hussain, S.S., Chaudhry, M.N. & Dawood, H., 1993. Emerald mineralization of Barang, Bajawar Agency, Pakistan. Journal of Gemmology 7, 402-408.

This is the first account of emerald mineralization from Barang, Bajaur Agency, NW Pakistan. Emerald mineralization is associated with talc carbonate host of the Indus suture ophiolitic mélange. The mineralization is pneumatolytic and hydrothermal late to post tectonic and structurally controlled. For the first time it is being recognized and proposed that the source of beryllium bearing fluids responsible for emerald mineralization are the Tertiary minor granites of S-type occurring in the area. This is contrary to the already held views that beryllium fluids emanated from a trench or arc source. The color of Barang emerald varies from light bluish green to deep green and the crystal range from minute to 2.5cm. This paper for the first time presents cell dimension of emerald from Pakistan by using an advanced computer program and four cycles of refinement.
Key words: Emerald, gemstone, mineralization, Bajaur.

H/257. Hussain, S.S., Chaudhry, M.N., Dawood, H. & Anwar, J., 1989. Geology and emerald mineralization of Barang-Turghao area, Bajaur Agency, Pakistan. Kashmir Journal of Geology 6 & 7, 87-102.

Geology and emerald mineralization of Barang-Turghao area have been studied for the first time. Rocks of the area are comprised of (a) granite gneisses, arenaceous, calcareous and argillaceous metasediments (rocks of Indian Plate) and (b) greenschists, greenstones, quartzites, gabbros and talc-carbonates (ophiolitic melanges zone). Emerald mineralization is associated with talc-carbonates. Petrographic and field studies reveal that this mineralization is pneumatolytic, post tectonic and structurally controlled. The source of the beryllium bearing fluids, responsible for emerald mineralization could be the non-foliated younger granites in the surroundings. It is also supported by the presence of the blue beryl in the area. Other minerals which may have some economic significance are hessonite garnet, green garnet, epidote, graphic and apatite.
Key words: Emerald, gemstone, mineralization, Bajaur.

H/258. Hussain, S.S. & Dawood, H., 1996. Beryl Mineralization of Higher Himalayas and its implications for emerald mineralization in Pakistan. Abstract volume, 11th Himalaya-Karakoram-Tibet Workshop, Flagstaff, Arizona (USA), 69.

Blue and green beryl in granites of Higher Himalayan Crystalline Block in Malakand Agency and district Dir has been found at a number of places. Emerald is being mined from the adjoining areas of Seat district and Bajaur Agency since the late sixties. The beryl mineralization has been studies in detail with the aim of determining its nature and to see its implications for emerald mineralization in the region.

Stratigraphically, the Higher Himalayan Crystalline block exposed to the south of the Main Mantle Thrust (MMT) is comprised dominantly of (i) granitoid-migmatic complex with metasedimentary enclave and abundant pegmatites, (ii) pelite-psammite sequence with abundant pegmatites, intrusive granites and contact migmatites and (iii) pelite-psammite of kyanite-sillimanite grade with pegmatites and granites. The beryl mineralization has been noted in simple pegmatites and hydrothermal/pneumatolytic veins including quartz veins, quartz-feldspar pegmatites, quartz-feldspar-mica pegmatites and quartz-feldspar-mica-fluorite pegmatites. The pegmatites and veins are of variable dimensions up to a few meters long and wide. Besides, in Dir District, quartz, quartz-calcite and quartz-ilmenite veins are observed to contain beryl mineralization. From the field observations it is noted that beryl mineralization phase is younger than quartz ilmenite phase.

The beryl mineralization is observed in pockets or cluster. The color of beryl varies from light blue, through deep blue to greenish blue. The crystal is usually small sized and fractured, opaque to translucent and slightly transparent.

Five samples of granite gneiss from the mineralized areas have been studied petrographically. These are mostly hypidiomorphic granular. Granite gneisses of Barh and Kot (Malakand Agency) have dominant orthoclase with only up to 2% albite, whereas Turghao and Agra gneisses have 34% and 35% albite/plagioclase respectively. Amphibole

(0.5% in each) is present in two samples. Muscovite and biotite occur as elongated flakes and impart gneissic structure to the rock. Feldspar shows alteration to clay. Calcite, epidote, sphene and ore minerals are the other accessories.

Two beryl samples from Badwan and Ramial, district Dir were analyzed chemically. Among the major elements, SiO_2 is 62.74% and 65.80%, Al_2O_3 is 13.23% and 16.08% and BeO is 12.99% and 7.31% in Badwan and Ramial samples, respectively. Comparison of major and trace elements in beryls from Badwan and Ramial (Dir) and Swat emeralds shows that Na is high in beryls as compared with emeralds, whereas Bi, Co, P, W and Zn is high in beryls found in hydrothermal/pneumatolytic veins than in pegmatitic beryls as well as emeralds. Cr, Ni and V are high in emeralds, which is attributed to the host ultramafics.

Beryls from Ramial and Badwan (Dir) and Barh and Batoo (Malakand Agency) have also been studied by XRD techniques. The cell dimension of beryls were found to cover the ranges: a=9.9216-9.259Å and c=9.189-9.219Å. The densities of beryl range from 2.611 to 2.633. It is the lowest case of the Badwan beryl.

The granites represent different episodes of magmatism. The younger fine-grained Tertiary granites intrude older Proterozoic granitic gneisses. The mineralized veins and pegmatites cut gneissic as well as younger fine-grained granites. Beryl mineralization found in quartz veins and pegmatites associated with Proterozoic granite gneisses as well as younger, undeformed Tertiary granites is widespread.

Based on field and laboratory studies, it is considered that the Be-B-F-Al bearing solutions, which gave, rise to beryl as well as emerald mineralization originated from the post-tectonic Tertiary granites. In the case of emeralds, the required Cr was imparted by the host talc carbonates.

Key words: Emerald, beryl, gemstone, mineralization, Malakand, Dir.

H/259. Hussain, S.S., Dawood, H. & Chaudhry, M.N., 1990a. Application of geochemistry to emerald exploration in Swat, Pakistan. Abstracts, 2nd Pakistan Geological Congress, University of Peshawar, 25-26.

Geochemistry has been rarely used for emerald exploration. The present studies for finding geochemical Pathfinders for emerald mineralization in Swat are significant.

Geochemical characteristics of the emerald bearing rocks o Emerald Mines have been determined. For this purpose, rock and stream sediment analyses of mineralized and non-mineralized areas were carried out using Induced Couple Plasma Emission Spectrometry. Multi-variate studies on the analytical results of 105 samples reveal that high Be, alongwith high Li, Sr and La may be taken as pathfinders for emerald mineralization in the Swat Emerald Mines.

Malam was selected as the target area where talc carbonates have the same physical and mineralogical characters like that of the Swat Emerald Mines. In this area, no significant anomalies could be distinguished using the geochemical model of Swat Emerald Mines; however, high Be and Li anomalies are evident in Malam stream sediments. Such geochemical studies, if caned out in conjunction with mineralogical and structural studies of a particular area, would be more helpful for pinpointing its emerald mineralization.

Key words: Emerald, gems, exploration, geochemistry, Swat.

H/260. Hussain, S.S., Dawood, H. & Chaudhry, M.N., 1990b. Ophiolite related manganese mineralization in Kassai, Lower Mohmand Agency and Shangla, Swat, Pakistan. Abstracts, 2nd Pakistan Geological Congress, University of Peshawar, 47p.

Ophiolite related manganese mineralization in Kassai area, lower Mohmand Agency has been studied and its comparison with that of the Shangla area, Swat has been done. Kassai Mn mineralization is observed as hydrothermal lenses and veins in tectonic block of quartzite in the Kot-Prang Ghar melange complex. Petrographic and chemical analyses of eight samples are presented. Samples of manganese ore of Kassai and Shangla contain upto 60% and 32.46% $Mn0_2$ respectively. Field observations reveal that Kassai area might contain more mineable reserves of similar nature.

Field and laboratory studies indicate that the manganese mineralization of Kassai and Shangla is of hydrothermal origin related to the volcanic activity during the closure of Tethys ocean. It is assumed that manganese has been incorporated hydrothermally in the oceanic sediments in shallow ocean environments during the tectonic activity.

Key words: Ophiolites, ultramafics, manganese, mineralization, Mohmand Agency, Shangla, Swat.

H/261. Hussain, S.S., Dawood, H. & Chaudhry, M.N., 1990c. Application of geochemistry to emerald exploration in Swat, Pakistan. Geological Bulletin, University of Peshawar 23, 45-65.

There are very few cases in the world where geochemistry has been used for emerald exploration. The present studies to fine out geochemical pathfinders for emerald mineralization in Swat are hence significant.

Geochemical characteristics of the emerald bearing rocks of Swat Emerald Mines have been determined. For this purpose rock and stream sediment analyses of mineralized and non-mineralized areas are carried out using Induced Couple Plasma Emission Spectrometry.

Univariate and multi-variate studies on the analytical results of 105 rocks and stream sediment samples of Swat Emerald Mines and Malam area were carried out. These studies reveal that high Be along with high Li, Sr and La may be taken as pathfinders for emerald mineralization in the Swat Emerald Mines.

Malam was selected as target area where talc-carbonate have the same physical and mineralogical characters like that of the Swat Emerald Mines. In this area no significant anomalies could be distinguished using the geochemical model of Swat Emerald Mines, however, high Be and Li anomalies are evident in Malam stream sediments. Such geochemical studies, if carried out in conjunction with mineralogical and structural studies of a particular area, would be more helpful for pinpointing its emerald mineralization.

Key words: Ophiolites, ultramafics, manganese, mineralization, Mohmand Agency, Shangla, Swat.

H/262. Hussain, S.S., Dawood, H. & Chaudhry, M.N., 1992. Significant characteristics of the World's major emerald deposits and their relevance to emerald mineralization in N.W. Himalayas, Pakistan. Abstracts, First South Asia Geological Congress, Islamabad, p.56.

Key words: Emerald, mineralization.

H/263. Hussain, S.S., Dawood, H. & Chaudhry, M.N., 1995a. Mineralization associated with the Himalayan suture zone of Pakistan. Abstracts, International Symposium on Himalayan Suture Zone of Pakistan. Pakistan Museum of Natural History, Islamabad, p.10.

The authors briefly described the Indus Suture rocks and associated ophiolitic mélange. A number of metallic/non-metallic mineral and gemstone reported form the suture include emerald/beryl, manganese, chromite, nickel, green garnet, epidot, rodingite and talc.

Key words: Mineral deposit, Suture zone, Himalayan

H/264. Hussain, S.S., Dawood, H. & Chaudhry, M.N., 1995b. Green Garnet (Tsavorite) Mineralization in Higher Himalayan Basement Rocks of NorthWest, Pakistan. Abstract Volume, 10th Himalaya-Karakoram-Tibet Workshop, (ETH Zurich) Switzerland.

This is the first detailed account of the vanadium and chromium bearing green garnet (tsavorite) mineralization associated with metasediments and carbonatites of Higher Himalayan crystalline slab of Bajaur and Malakand agencies and Swat district, north- west Pakistan.

Euhedral and anhedral tsavorite in Jambil, Swat is found in quartz veins within graphitic schists which are part of Proterozoic basement pelitic-psammitic metasediments, metamorphosed to upper amphibolite facies and intruded by granitic rocks of Tertiary? as wells as 400 Ma, 51 0-560 Ma, 580-600 Ma, 1517 Ma, 1970-2031 Ma in age. These rocks make the northern margin of the Indian plate, south of the Main Mantle Thrust.

In Mairagai (Swat), Selai Patti (Malakand Agency) and Bagh-Turghao (Bajaur Agency) green garnet bearing carbonatites are exposed in a linear belt of more than 100 kms and occur as sheets, sills, ring type and lensoidal bodies of variable dimensions. These rocks are generally medium to coarse grained, white, earthy white to brownish in colour having sugary texture.

Selai Patti (Malakand Agency) and Bagh-Turghao (Bajaur Agency) carbonatites show alteration to feldspathic material along joints and in certain zones, which are mineralized. However, in Mairagai (Swat) no such alteration has been seen. The altered parts of carbonatite in Selai Patti and Bagh-Turghao areas lack the ferro-magnesian minerals however non-crystalline green garnet is present in these zones as aggregates. The carbonatites are composed of calcite, siderite with variable quantity of amphibole, pyroxene, biotite, vermiculite, sphene, apatite, pyrite and garnets. At places crystals of amphibole, pyroxene and vermiculite flakes occur as aggregates. Sphene and apatite are transparent to translucent. The carbonatites in Selai Patti area locally contain a few apophysis of undeformed Tertiary? granite. Quartz, feldspar and amphibole bearing pegmatites also cut these carbonatites in Mairagai and Selai Patti area. The carbonatites and pegmatites show tight folding and appear to have suffered multiple deformation. In carbonatites the green garnet occurs either as disseminated crystals or their aggregates and range in size from tiny specks to 1 cm across. These are generally transparent to translucent. The colour varies from light pale green, olive green to mottled green.

The garnet of Jambil area is generally dark green and occurs as disseminations and crystal aggregates in hydrothermal quartz veins and in the graphitic schists adjacent to the quartz veins. Inclusions of graphite and mica are common. These transparent to translucent garnets can be cut in exquisite melle sized gems.

The cell dimensions of two crystals of Jambil (Swat) green garnet and one each of Turghao and Mairagai were determined on X-ray diffractometer. In Jambil green garnet the cell dimensions are 11.8902 Ao and 11.8809 Ao with SD of 0.0005 and 0.0087 respectively. Turghao and Mairagai garnets have 11.8453 Ao with SD of 0.0125 and 11 .8650 Ao with SD of 0.141. Chemical analyses of green garnets from these areas are also presented in this paper. The green garnet of Jambil is high in Ca, typical of grossular garnet. High V and small quantity of Cr impart deep green colour to the Jambil green garnet. However the garnets in carbonatites have both V and Cr but in very small quantity compared with that of Jambil. The occurrence as well as physical and chemical properties of green garnet indicate their mineralization in two different geological environments.

Key words: Garnet, mineralization, Swat.

H/265. Hussain, S.S., Dawood, H. & Chaudhry, M.N., 1997. Talc/magnesite deposits along Main Karakoram Thrust zone, N. Pakistan. Abstracts, National Symposium on Economic Geology of Pakistan, Islamabad, 1p.

Extensive occurrences of talc/soapstone and magnesite from Shishi Valley. Chitral and from Yasin and lshkuman valleys. Gilgit are being reported and studied in fair detail for the first time. These talcose rocks occur within the Main Karakoram Thrust Zone (MKTZ), which extends for a distance of more than 300 kms from the Pak-Afghan border near Mirkhini. Chitral and continues in the east through Shishi. Yasin. Lshkuman, Hunza and Shigar valleys, Northern Areas. The ultramafics which variably alter to talc carbonates are serpentinite, serpentinized harzburgites and serpentinized dunite. These studies have revealed that the talc rich bodies are intimately associated with border areas of talc carbonates. Talc may constitute upto 70% of these rock and in a few bodies it may go as high as 80%. Petrographic and chemical analyses of these rocks are also presented. These bodies are measurable from a few metres in tens of metres wide and upto hundred of metres long. These talcose rocks, thus, have huge reserves. The laboratory scale beneficiation test show that these rocks can be upgraded for commercial use. Magnesite can also be obtained from these rocks as a bye-product. These talcose deposits merit detailed economic evaluation.

Key words: Talc, magnesite, MKT, Chitral, Yasin.

H/266. Hussain, S.S., Dawood, H., Chaudhry, M.N. & Weiss, M., 2001. Geochemistry and genesis of manganese mineralization in Kasi and Moto Shah area, Mohmand Agency, Pakistan. Abstracts, 4th Pakistan Geological Congress, Islamabad, p.68.

Manganese mineralization occurring in meta-cherts of the Indus suture zone melange in Mohmand Agency has been studied in detail. The mineralized meta-cherts in Kasai and Moto Shah areas. Mohmand Agency are part of the Kot-Prang Ghar melange complex where all the lithologies of ophiolites, intact as well as dismembered, are exposed (Hussain et al., 1984).

Petrographically the Kasai ore comprises upto 30% manganese ore minerals. The manganese ore and gangue of Kasai area are characterized by the presence of 3% and 60% piedmontite and 20% & 5% garnet, respectively. The manganese ore of Kasai contains upto 60% Mn02. The associated spassertine garnets are quite rich in manganese with 32.65 to 37. 14% Mn02 whereas Si02 ranges from 36.11 to 42.97%, A1203 from 19.75 to 21.18% and CaO from 3.57 to 4.20%. Microprobe studies were also carried out on two samples, which show that the Kasai manganese ore comprises brahnite as well as rhodonite.

Fe/Mn ratio of manganese ore in Kasai ranges from 0.035 to 0.037 whereas in Moto Shah this ratio is 2.05. The trace element contents and Fe/Mn ratio suggest that Kasai manganese mineralization is hydrothermal whereas that of

Moto Shah appears to be hydrogenous. The presence of spessartine garnet, piedmontite and other associated minerals in the Kasai manganese deposit suggest that these rocks suffered low temperature, high-pressure metamorphism. Geochemistry, morphology and sedimentological & geotectonic setting of these deposits suggest that manganese mineralization in Kasai, Mohmand Agency originated as a result of submarine hydrothermal activity in the Tethyan Ocean.
Key words: Geochemistry, manganese, mineralization, microprobe, Mohmand Agency

H/267. Hussain, S.S., & Iqbal, M., 1975. Field Report on the geology and petrology of Malakand and Chakdara. M.Sc. Thesis. Geology Department, Punjab University, Lahore.

Key words: Petrology, maps, Malakand, Chakdara.

H/268. Hussain, S.S., Khan, T., Dawood, H. & Khan, I., 1984. A note on Kot-Prang Ghar melange and associated mineral occurrences. Geological Bulletin, University of Peshawar 17, 61-68.

Lower Mohmand and western part of Malakand Agency are characterized by ophiolitic Late Jurassic to Cretaceous Melange Complex. Middle to Late Paleozoic metasediments, and Malakand-Kot and Silai Patti-Kolangi granitic gneisses of Cambrian age make up the rest of the rock sequence within the area. Thrust faults, intricate folds, joints and complex foliation planes are the major structural features. These structures are the result of multiple tectonic events in this region. Gemstone and metallic ore mineralization has taken place in the Melange Complex, of which emerald, epidote, beryl, rutile, jadeite/nephrite, manganese and chromite may be of economic significance.
Key words: Ophiolites, ultramafics, Jurassic, Cretaceous, Melange, Prang Ghar, Malakand.

H/269. Hussain, S.S., & Wazir, A.K., 1999. Structure, stratigraphy and tectonic setup of a part of northern Suleman Range, North Waziristan Agency, N.W.F.P. M.Sc. Thesis, University of Peshawar, 71p.

Key words: Structure, stratigraphy, tectonics, Suleman Range, North Waziristan Agency.

H/270. Hussain, S.T., 1970a. Status and scope of mineral statistics in the mineral industry of Pakistan. Proceedings, National Seminar on Mineral Development, Lahore, 20-23rd April, 1970.

Key words: Mineral industry.

H/271. Hussain, S.T., 1970b. Summary review of gypsum, its projected demands in saline-alkali soils of West Pakistan. Proceedings, National Seminar on Mineral Development, Lahore, 20-23rd April, 1970.

Key words: Gypsum, soils.

H/272. Hussain, S.T., 1973. Appearance Hipparion in the Tertiary of the Siwalik Hills of north India, Kashmir and Pakistan. Nature, 246-531.

The earliest occurrence of *Hipparion*, a tridactyl fossil equid, in the Tertiary of the Siwalik Hills (Pakistan and India) has been discussed by Simon et al. Their statements are confusing and they have misinterpreted one of my publications. Simons *et al.* [1] reject a possible Chinji occurrence of the genus, partly because “Hussain has pointed out that regardless of the validity of occurrence of the *Hipparion* reputed to have been found near the base of the Chinji, the teeth of these specimens are very large. It is implausible that such animals should have preceded in time the small and structurally different species *Hipparion nagriensis* Hussain”.
Key words: Palaeontology, Siwaliks, Tertiary, India Pakistan.

H/273. Hussain, S.T., 1984. Paleo-environmental studies of continental sediments in Pakistan. Abstracts, First All Pakistan Geological Congress, Lahore, p.43.

The study of paleoenvironments in the geological time is of great importance for the evaluation of life and processes of mineralization. In the continental sediments, paleo-channels and paleoriver systems have been studied which point out sources of certain minerals and animal life. It has been established that Indo-Pak Plate collided with Asia in Paleocene times, the first evidence of land mammals has been seen in early Eocene in Pakistan. The biostratigraphic and cromuohaps ancestors of certain orders. The biostratigraphic and cromu-stratigraphic correlations within Pakistan help in the determination of similar peloenvironments which may lead to the formation of certain mineral deposits and development of life. The process of evolution is a complex one which involves chemistry of the animals and the morphology changes in spurts. The evidence is seen in certain groups such as trilobites, reptiles and mammals. The change in environments can also produce abnormal chemistry which ultimately may result in pathologic morphology.
Key words: Sediments, paleoenvironments.

H/274. Hussain, S.T., 1986. First appearance of land mammals on Indo-Pakistan subcontinent. Abstracts, Symposium/Workshop on Plate Tectonics and Crust of Pakistan. Institute of Geology, Punjab University, Lahore, p.18.

The etenodsetyloid rodents and several specimens of a new dichobunid artiodactyl, Discodexis Pakistanensis have been found in the Kuldana Formation of the Kohat area. These are the earliest land mammals ever found on the Indo-Pakistan Subcontinent. The etenodsctyloids from Kohat, one of the oldest records of the super-family, have lophodont upper cheek teeth. The micro-structure of the enamel of the incisors is diversified. The discovery of Discodexcis Pakiatanensis in Kohat establishes the presence of Discodexis on all continents of the northern hemisphere at the beginning of the Eocene and possibly suggests an Asian Origin for the Artiodactyla. It is now established that the land mammals arrived on the Indo-Pakistan Subcontinent from Central Asia approximately 50 million years ago. This confirms that the Indo-Pakistan Subcontinent, which was originally part of Africa, collided with Asia prior to this time. Soon after that there was a major influx of land vertebrates, particularly of mammals into the Indo-Pakistan Subcontinent.
Key words: Palaeontology, mammals, Kuldana.

H/275. Hussain S.T., DeBrujn, H. & Leniders, J.M., 1978. Middle Eocene rodants from the Kala Chitta Range (Punjab, Pakistan). Kan. Nederland Akad. Wetensche. Series B, 8, 81-112.

Key words: Rodents, Eocene, Kala Chitta.

H/276. Hussain, S.T. & Khan, A.L., 1969. Fire clay deposits of Kala Chitta Range District Campbellpur, West Pakistan. Geological Survey of Pakistan, 89.

Key words: Fire clay, Kala Chitta, Campbellpur.

H/277. Hussain, S.T., Munthe, J., Shah, S.M.I., West, R.M. & Lukas, J.R., 1979. Neogene stratigraphy and fossil vertebrates of Daud Khel area, Mianwali District. Geological Survey of Pakistan, Memoir 13, 27p.

Key words: Palaeontology, vertebrates, Siwaliks, Mianwali.

H/278. Hussain, S.T., Munthe, J., West, R.M. & Lukas, J.R., 1977. The Daud Khel local fauna: A preliminary report on a Neogene vertebrate assemblage from Trans-Indus Siwalik, Pakistan. Milwaukee Public Museum, Contributions in Biology and Geology 16, 17p.

Key words: Palaeontology, Vertebrates, Siwaliks, Tertiary, Trans Indus.

H/279. Hussain, S. T., Sonders, P.Y. & Shah, S.M.I., 1983. Fossil mammal bones of Pakistan: A field atlas. Geological Survey of Pakistan, Memoir 14.

Key words: Palaeontology, Vertebrates, Mammals.

H/280. Hussain, S.T., Van den Bergh, G.D., Steensma, K.J., De Visser, J.A., De Vos, J., Arif, M., Van Dam, J., Sondaar P.Y. & Malik, S.M., 1992. Biostratigraphy of the Plio-Pleistocene continental sediments (Upper Siwaliks) of the Mangla-Samwal Anticline, Azad Kashmir, Pakistan. Proceedings of the Koninklijke Nederlandse Akademie Van Wetenschappen. 95 (1), 65-80.

Key words: Biostratigraphy, sediments, Plio-Pleistocene, Azad Kashmir.

H/281. Hussain, T., 1972. Geology of the Manarai Banda area, Upper Swat, with special emphasis on mineralogy of the area. M.Sc. Thesis, Punjab University, Lahore, 69p.

Key words: Petrography, Swat.

H/282. Hussain, T., 1984-85. Geology and structure of Reshian-Lamnian-Panhkot-Nauseri Area Neelum-Jhelum valleys District Muzaffarabad, Azad Kashmir, Pakistan. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 78p.

This report comprises a complete geological study based on mapping of nearly 180 sq. km. located between Beehian-Nauseri of Jhelum and Neelum Valleys respectively. Special emphasis has been put on describing the tentative stratigraphic correlation of the rock units. In the project area a large number of rock units including volcanics, microaugengneiss, micaceous quartzites, quartz mica schists, granite gneiss, sandstones, shale, and siltstones are encountered. A stratigraphic sequence has been worked out. The rocks extend in age from Devonian to Miocene and have been correlated with Tanawal Formation, Agglomeratic Slates, Panjal Formation and Murree Formation respectively. Structurally, the rocks are folded into a number of major structures which are now separated from each other by mostly north dipping high angle thrust faults. The area comprises of two major thrusts known as Murree Thrust/Main Boundary Fault and Panjal thrust. Hazara Kashmir syntaxis has a great influence on the stratigraphy, structure and tectonic of the investigated area. That is why we have generally interpreted our results with respect to the syntaxis, as the project area lies on its eastern limb. In the field of economic geology a number of economic deposits including marble, graphite, gypsum and building-stone have been discussed. This report also includes a petrographic description of the rock units as well as numerous sketch section and photographs, illustrating the geology of the area.

Key words: Structure, maps, Neelum-Jhelum valley, Azad Kashmir.

H/283. Hussain, T. & Naqvi, A.A., 1973. High aluminous clay deposits of the Punjab province, Pakistan. Geological Survey of Pakistan, Information Release 59, 16p.

Deposits of fire Clay/bauxite of commercial significance occur in the salt range and the Kala Chitta Range. These deposits have been investigated under a joint project of G.S.P. and P.C.S.I.R. Geological mapping of these deposits has been carried out by the G.S.P.

Mineralogical and chemical tests of the samples discussed in this report indicate that the clays are free from any visible impurities, their plasticity varies from fair to moderate and their slacking bevariour is slow. AS a whole the composition and characteristics of the high aluminous clay deposits of Salt Range and Kala Chitta range are fairly conformable with the specifications laid down by the Soviet experts for the clays required for the proposed Karachi

Steel Mill. The total reserves estimate of the deposits discussed in this report are a little over 85 million tons and as such these are enough to meet the annual requirement of 75,000 tons of clay for Karachi Steel Mill for several decades.
Key words: Clay, high alumina, Punjab.

H/284. Hussain, V., Bilqees, R. & Hussain, A., 1995. Industrial mineral resources of Pakistan. SEGMITE Souvenir on International Symposium on Phosphate and Industrial Minerals, at Abbottabad, 21–25 May, 1995.

Key words: Industrial minerals.

H/285. Hussain, V. & Kaifi, Z., 1995. Industrial mineral potential of North Pakistan and scope for trade and technological cooperation between Pakistan and Sri Lanka. In: Abstract volume Dissanayake, C.B., Almond, D.C. & Cooray, P.G., (Eds.), Second South Asia Geological Congress, (GEOSAS-II), Colombo, Sri Lanka, p.237.

Key words: Industrial minerals.

H/286. Hussain, V., Khan, M.M. & Siddiqui, F.A., 1990. Vein type barite deposits in Kag, Aluli and Darwaza near Haripur, NWFP, Pakistan. 2nd Pakistan Geological Congress Abstract, 9p.

Key words: Barite, Haripur.

H/287. Hussain, V., Qaiser, M.A., Ahmad, N. & Bilqees, R., 1987. Petrology of Kakul phosphorites, district Abbottabad, NWFP, Pakistan. Geological Bulletin, University of Peshawar 20, 153-160.

Two basic types of phosphorites have been recognized within the Kakul stratigraphic sequence: 1) authigenic mirocrystalline phosphorite mud (microphorite) or orthochemical phosphorite which has precipitated either biochemically or physiochemically, and 2) pelletal phosphorite or allochemical phosphorite which has been modified into discrete clastic particle from microphosite mud. Microscopically, the primary component is the carbonate fluorapatite matrix with cryptocrystalline dolomite, calcite and quartz. Also there are detrital grains of quartz, dolomite, and calcite with disseminated ferruginous matter.
Key words: Stratigraphy, phosphorite, Kakul, Abbottabad.

H/288. Hussain, V., Siddiqi, F.A., Qureshi, K.M. & Ghani, A., 1987. Petrology of barite deposits of southern Hazara, N.W.F.P., Pakistan. Geological Bulletin, Punjab University 22, 136-142.

The barite occurring in Southern Hazara district near Haripur is snow-white in colour. Barite is coarse grained massive and compact in nature. Barite occurs mostly as veins which contains impurities consisting of quartz, calcite, and traces of pyrite, iron oxide and copper. Barite in tanol area are mostly hosted in quartzitic sandstone and are cavity filling and epithermal vein type deposits.
Key words: Petrology, barite, Hazara.

H/289. Hussain, V., Ullah, W., Qaiser, M.A. & Siddiqi, F., 1992. Clay deposits of Pakistan. In: Nagaswa, K. (Ed.), Clay Minerals, their Natural Resources and Uses. Proceedings of Workshop WB-1, 20th International Geological Congress, 97-105.

Key words: Clay.

H/290. Huzita, K., 1965. Geological research in Gilgit. Ishkuman and Yasin areas. In: Matshushita, S., and Huzita, K., (Eds.), Geology of Karakorum and Hindu Kush. Kyoto University Science Exped. 1955, vol. VII, 7–36. Nippon printing & Publishing Co., Ltd. Japan.

This is a detailed description of the sections along the Gilgit, Yasin and Ishkuman river valleys. The lithologic and other characteristics of the (meta)sedimentary rocks, volcanics and greenstones, granite gneisses and granites, glacial and stream deposits along the courses of the rivers are describes and compared with others in the Karakoram. Fossil species in the Yasin valley are also described. The text descriptions are supported by 14 excellent hand sketches and 12 photographs. Huzita compared his geological divisions with those of Ivanac et al. (1956) and Schneider (1957, 1960) as follows.

Geological division of Gilgit-Ishkuman-Yasin areas.

Researcher	K. Huzita	J. F. Ivanac	H. J. Schneider
Division	7) Quaternary deposits	7) Quaternary deposits	
	6) Granite of Ghizar valley	6) Ladakh Granodiorite	?) Zone H
	5) Gneiss of Gilgit	2) Karakoram Granodiorite	5) Zone I
		2) Darkot Pass Granodiorite	
	4) Yasin group	4) Yasin group	3) Zone II
	3) Green series	3) Green Complex	1?) Zone III
	2) Granite of Karambar		2) Zone IV
	1) Darkot group	1) Darkot group	1) Zone V

Key words: Geology, lithology, stratigraphy, sedimentology, Gilgit, Karakoram.

H/291. Hyland, F.D., 1957. Mineral resources of Pakistan. Mineral Trade Notes, US Bureau of Mines 45(6), Special Supplement 50, 49p.

Key words: Mineral resources.

H/292. Hyland, F.D., 1958. Bauxite in Pakistan. Mineral Trade Notes, US Bureau of Mines 46(6).

Key words: Mineral resources, bauxite.

H/293. Hylland, M.D., Riaz, M. & Ahmad, S., 1988. Stratigraphy and structure of the southern Gandghar Range, Pakistan. Geological Bulletin, University of Peshawar 21, 1-14.

The southern Gandghar Range is composed of a succession of marine strata of probable Proterozoic age, consisting of a thick basal argillaceous sequence (Manki Formation) overlain by algal limestone and shale (Shahkot, Utch Khattak, and Shekhai Formations). These rocks are thrust southeastward over the Kherimar Hills succession along the Panjal fault. The Gandghar Range and Kherimar Hills successions correlate with the northern and central blocks of the Attock-Cherat Range, respectively, indicating that the combined Panjal-Khairabad fault juxataposes two major, laterally continuous structural blocks.

The rocks of the southern Gandghar Range occur in two structural blocks juxtaposed along the Baghdarra fault. The hanging wall consists entirely of isoclinally-folded Manki Formation, while the footwall consists of the complete Manki-Shekhai succession which has been deformed into tight, northeast-plunging, generally southeast-verging disharmonic folds. The Baghdarra fault is apparently deformed along with the footwall strata, indicating that it is older than, and is being carried piggy-back style on, the Panjal fault. Phyllite near the Baghdarra fault displays asymmetric deformation of foliation around garnet porphyroblasts, kink bands, and a poorly-developed s-c fabric. These features are consistent with conditions of dextral shear, indicating reverse slip displacement along the fault.

Key words: Stratigraphy, structure, mapping, Gandghar, Hazara.

H/294. Hytton, J.W., 1969. Appraisal of phosphate in Pakistan. Geological Survey of Pakistan and U.S.G.S. Project Report, PK (IR)–53, 36p.

Key words: Phosphat.