Y/1. Yafeng, S. & Xiangsong, Z., 1984. Some studies of the Batura glacier in the Karakoram mountains. In: Miller, K.J. (Eds.), The International Karakoram Project, Volume 1. Cambridge University Press.

In 1974 and 1975, using terrestrial stereophotogrammetry, the Glacier Investigation Group of China made a survey of the Batura Glacier drainage area and drew a 1:60,000 map. A glacial inventory has been accomplished and much data on morphological measurements obtained. The Batura Glacier has some continental-type characteristics but there are number of maritime features; we call the Batura “a complex type glacier”. According to our forecast, the glacier will advance another 180-240 m but in the 1990’s it will once again be on the decline.
Key words: Glaciers, Batura, Karakoram.

Y/2. Yafeng, S. & Wenyingt, W., 1980. Research on Snow Cover in China and the Avalanche Phenomena of Batura Glacier in Pakistan. Journal of Glaciology, 6(94).

This paper summarizes the state of research in China on snow cover, snow-drift control, and avalanche defences, and also reports the results of observations of avalanching above Batura Glacier, Pakistan, during two expeditions.
Key words: Glaciers, avalanche, Batura, Karakoram.

Y/3. Yamin, F., 1981-83. Geology and petrology of Tangir valley (District Diamer) with special emphasis on the mineralogy/petrology of the intrusives. M.Sc. Thesis, Punjab University, Lahore, 143p.

Tangir covers 351 square kilometers area located between Kohistan in the South and Yasin in the North. Accoroing to plate tectonic concept it lies in between Indo-Pakistan and Eurasian plates comprising a part of Kohistan Island arc. The particular project area is mapped on a scale of 1:62500. In the thesis, an attempt is made to introduce the detailed Geology of the area. Bulk geological sequence of the area is consisted of Norite, Diorite, Amphibolite, Granodiorite and granite which is obducted on to the Paleozoic rocks of Indo-Pakistan plate in the South and subducted under the Eurasian plate towards the North. The Northern part of the area is in contact with Yasin Group which is volcanic. So Tangir area constitutes the lower sequence of Kohistan Complex.
Key words: Geology, petrology, igneous rocks, amphibolites, Tangir, Diamir.

Y/4. Yammoto, H., 1993. Contrasting metamorphic P-T-time paths of the Kohistan granulites and tectonics of the western Himalayas. Geological Society London Journal 150, 843-856.

In the Swat-Indus Kohistan area, lower crustal rocks of the Kohistan arc including amphibolites, granulites and ultramafic rocks are widely exposed. Detailed petrological-structural studies reveal that the Chilas-Jijal metamorphic complex comprises essentially intermediate- to high-pressure granulites with a granulite/amphibolite transition controlled by extensive retrograde metamorphism and ductile deformation. Contrasting patterns of compositional zoning in garnet and orthopyroxene suggest complicated P–T paths in the granulites. Geothermobarometry based on garnet-bearing granulites identify two distinct P–T–time paths: a high-pressure anticlockwise path of the Jijal complex and a low-pressure retrograde path of the Chilas complex. These P–T–time paths represent the evolution of middle to lower crustal rocks of the Kohistan arc. The anticlockwise P–T-time path combined with published isotopic ages reveals that: (i) the high pressure granulite facies metamorphism is related to the Kohistan-Asia collision and (ii) the crust of the Kohistan arc had been thickened at least 55 km before the India-Asia collision.
Key words: Tectonics, P-T-t paths, Chilas complex, Jijal complex, Kohistan.

Y/5. Yamamoto, H. & Nakamura, E., 1996. Sm-Nd dating of garnet granulites from the Kohistan Complex, northern Pakistan. Journal of the Geological Society, London, 153, 965-969.

Sm–Nd mineral-isochron ages of garnet granulites in the southern part of the Kohistan complex are determined. The 91.0 ± 6.3 Ma age is obtained from a granulite body of the Jijal complex at Pattan and the 69.5 ± 9.3 Ma age is obtained from a granulite body of the Chilas complex at Zambil. These ages indicate that the granulite bodies at Pattan and at Zambil had cooled to below upper amphibolite facies by about 90 Ma and about 70 Ma respectively.

The time of cooling of the granulite of the Jijal complex is comparable to the time-lapse of the Asia–Kohistan collision (102–75 Ma), although that of the Chilas complex is probably younger than the Asia–Kohistan collision and certainly older than the Asia–India collision (c50 Ma).
Key words: Geochronology, Sm-Nd dating, granulites, Jijal, Kohistan.

Y/6. Yamamoto, H. & Nakamura, E., 1998. Sm-Nd dating of superposed replacements in mafic granulites of the Jijal Complex, Northern Pakistan. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13^{th} Himalayan-Karakoram-Tibet International Workshop, 216-218.

The northern part of the Jijal complex (NJC) in the Kohistan arc is a rare example of the lower crust of an island arc. Two stages of replacement under the granulite facies conditions are observed in maflc to ultramafic rocks of the NJC. In the earlier stage, garnet clinopyroxene granulite (garnet+clinopyroxene+plagioclase+quartz) replaced two-pyroxene granulite (orthopyroxene +clinopyroxene ± homblende + plagioclase ± quartz) and patches of relict, the two-pyroxene granulite, were left in the garnet-clinopyroxene granulite. In the later stage, many pod- and lens-shaped bodies of garnet hornblendite (garnet+hornblende +clinopyroxene) replaced the garnet-clinopyroxene granulite. The two-pyroxene granulite and the garnet-clinopyroxene granulite are nearly equivalent in chemical composition and distinct from the garnet hornblendite.
Sm-Nd isotopic systems have been studied in these three rock types. Samples for dating were collected from roadside sections along the Karakoram Highway around lat. 35'07' N and long. 73'00' E (near the Pattan village). Whole rock and mineral isochrons define the following ages: I 1 8 ± 12 Ma for KU66A (two-pyroxene granulite), 94.0±4.7 Ma for PD6B (garnet-clinopyroxene granulite), and 83 ± 10 Ma for PDI5B (garnet hornblendite). Errors in ages are quoted as 2o. The age of KU66A shows that the protolith of two-pyroxene granulite had been formed before the Kohistan-Asia collision, which is dated between 102 and 85 Ma [1, 2]. The age of PD6B agrees with a 91.0 ± 6.3 Ma Sm-Nd age of KU66 (the garnet-clinopyroxene granulite from the same outcrop of KU66A in this study) in an earlier report [31. All the above ages are consistent with relative order of the formation of the three rock types. The earlier replacement took place before c. 90 Ma (PD6B, KU66) and the later probably before c. 80 Ma (PDI5B). The result implies that these events in the NJC are related to the Kohistan-Asia collision.
Key words: Geochronology, Sm-Nd dating, granulites, Jijal, Kohistan.

Y/7. Yamamoto, H. & Nakamura, E., 2000. Timing of magmatic and metamorphic events in the Jijal complex of the Kohistan arc deduced from Sm-Nd dating of mafic granulites. 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, 313-319.

Mafic to ultramafic granulites in the northeastern part of the Jijal complex include two-pyroxene granulite, garnet-clinopyroxene granulite and garnet hornblendite. Field and textural relations indicate that two-pyroxene granulite is a relict left after formation of the garnet-clinopyroxene granulite and garnet hornblendite was an originally intrusive rock, which dissected the protoliths of mafic granulites. Sm-Nd mineral isochron ages of 118 ± 12 Ma, 94.0 ± Ma and 83 ± 10 Ma were determined for two-pyroxene granulite, garnet-clinopyroxene granulite and garnet hornblendite respectively. These ages, together with previously reported chronological data, led to the following tectonic implications: (1) crystallization of the granulite protoliths predates, or is coeval with, the tectonic accretion of the Kohistan arc to the Asian continent; (2) crustal thickening related to the accretion was probably responsible for the high-pressure granulite-facies metamorphism in the Jijal complex; (3) formation of the garnet horblendite assemblage was probably after crystallization of garnet-clinopyroxene granulite.
Key words: Geochronology, granulites, Jijal, Kohistan.

Y/8. Yamamoto, H. & Yoshino, T., 1998. Superposition of replacements in the mafic granulites of Jijal complex of the Kohistan arc, northern Pakistan: dehydration and rehydration within deep arc crust. Lithos 43, 219-234.

Key words: Granulites, Jijal, Kohistan.

Y/9. Yaqoob, M., 1978-80. Geological mapping of Tarbela Dam. M.Sc. Thesis, Institute of Geology, Punjab University, Lahore, 142p.

Key words: Geology, structures, dams, Tarbela.

Y/10. Yaqub, H.M., 1973. Geological mapping and investigation of Chalt damsite, northwest Karakoram, Gilgit Agency. M.Sc. Thesis, Punjab University, Lahore.

Key words: Geology, structures, Chalt damsite, Gilgit, Karakoram.

Y/11. Yar, M., 1997-98. Geological mapping and hydrogeological studies of Rawalakot area (District Ponch) A.K. with special emphasis on microbiological study of water. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 56p.

Geologically, the area under study is situated Lesser Himalayas Precambrian to recent rocks are exposed. Most of the area is covered by thick vegetation and rangelands. Samples were collected from springs, wells and streams for pollutants and bacterial study. The source of pollutants is faecel marked by the coliform organisms. Septic tanks, uncontrolled disposed off liquid and solid waste by the community, disposed off solid and liquid wastes from C.M.H and the fine sediments from Murree Formation contaminated the water as a whole. The rainwater flow through Murree Formation and the dissolution of carbonate and bicarbonate and other minerals from Murree Formation and the soils are also effected the water quality. The toxic metals like lead, zinc, copper and manganese coming into the water through aluminum pipes, or from the fitting used for the pipes. All the above sources arise the health based problems to the community in Rawlakot area. The diseases like enteric fever, typhoid, dysentery, diarrhea, cholera, abdominal pains and gastric enteric, brain hemorrhage and heart problems are water borne common infections in community. From the results it has been concluded that the drinking water from the springs, wells and streams are mostly at intermediate to high risk.
Key words: Mapping, hydrogeology, Rawlakot, Azad Kashmir.

Y/12. Yaseen, C.M., 1995-96. Structure, stratigraphy, micropaleontology and petrography of Darthian, Narota & Karwal areas, Districts Haripur, Hazara (NWFP), Pakistan. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 95p.

The Darthian, Narota and Karwali area are part of Attock-Hazara fold-and-thrust belt of the northwest Himalaya of Pakistan. The lithographic units exposed in the area are mainly sedimentary in nature and range in age from Mesozoic to Cenozoic. The area is deformed by folding and faulting during the Tertiary-Himalayan collision. The Early Cretaceous Lumshiwal Formation has conformable contact with the overlying Late Cretaceous Kawagarh Formation. The presence of glauconite in the Lumshiwal Formation reveals that the formation was deposited in marine condition during regressive as well as transgressive phases. The Late Cretaceous subduction of the Indian plate below the Kohistan Island arc caused the deepening of the Tethyan shelf in the subduction zone and initiated the deep marine deposition of the Kawagarh Formation. The contact between Kawagarh Formation and Early Paleocene Hangu Formation is marked by break in deposition which is evidenced by the presence of laterite/haematite and sandstone. The abrupt change in facies from deep water marine environment of Kawagarh Formation to terrestrial deposition of Hangu Formation indicates the initial Early Paleocene collision of the Indian Plate and Kohistan Island arc. The Lower Tertiary sequence exposed in the area is Early to Late Paleocene Lockhart limestone, Late Paleocene Patala Formation, Early Eocene Margalla Hill Limestone, Early Eocene Chorgali Formation and Early to Middle Eocene Kuldana Formation. The Lower Tertiary sequence marks the complete cycle of transgression and regression of the Tethyan Sea. The presence of early Paleocene to Late Eocene foraminiferal assemblage like globorotalia, globogorina, lockharia, assilina and nummulites in the limestones and shales of the Lower Tertiary sequence show the tropical sub-tropical open sea upper slope to outer shelf environments. The Kuldana Formation is composed of marine limestone, continental variegated clay, shales and evaporitic gypsiferrous bands. These variegated litholgies show that the Early to Middle Eocene Kuldana.
Key words: Structure, stratigraphy, palaeontology, petrography, Haripur.

Y/13. Yasin, A.R., 1982-84. Structural studies of Chinarkot-Galidada Area, District Mansehra. M.Sc. Thesis, Punjab University, Lahore, 87p.

The landforms bear a specific relationship with geological structures and the climate which can be worked out by qualitative as well as quantitative analysis of the topographic map. The most predominant lithologies of the project area are garnet mica schists, and Susalgali granite gneiss. The rocks of the project area have been classified into eight lithologic units for the sake of mapping purposes at a scale of 7 Cm. to a kilometer. Mesoscopic deformational structures are well exhibited in the project area including both planner and linear structures. The rocks have been folded isoclinally and later being refolded into open folds. The area is traversed by a shear zone, the Chalundri fault and is divisible into two structural domains. The area is deformed by different deformation phases, among which three are recognized on mesoscopic as well as microscopic scale and area is characterized by heterogeneous deformation. The rocks have been folded isoclinally and later being refolded into open folds. The area lies in the core zone of the regional synformal structure of the Mansehra Complex which has experienced metamorphism in Barrovian style. The project area has been metamorphosed up to garnet grade with local contact metamorphic effects along the contacts of granites.
Key words: Structure, granite gneiss, Metapelites, Mansehra.

Y/14. Yasin, M.M., Agha, M.A. & Khattak, Z., 1976. Groundwater appraisal of Haripur plain. M.Sc. Thesis, University of Peshawar, 65p.

Key words: Groundwater, Haripur, Hazara.

Y/15. Yasir, A., 1988-90. The geology and petrology of Jijal and Pattan layered ultramafics-mafic complexes in the vicinity of Jijal & Duber with special emphasis on petrogenesis of these complexes. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 90p.

The project area covers about 368 sq. Km. located in the vicinity of Jijal & Duber, District Kohistan. The work has involved geological mapping of the area on a scale of 1:50.000 of toposheet No. 43 A/16 of Survey of Pakistan. This thesis deals with the geology, petrography and petrogenesis of the Jijal and Pattan complexes in particular and the relation of these complexes with other complexes of Kohistan Arc complex has also been discussed.
The geological sequence of Jijal complex consists of ultramafic and mafic cumulates. The ultramafic cumulates are divided into dunite, wehrlite, websterite. garnet-pyroxenite and garnet-hornblendite, whereas mafic cumulates are garnet gabbro. The geological sequence of Pattan complex also consist of ultramafic and mafic cumulates. The ultramafic cumulates are chromite, dunite and (meta) wehrlite, whereas mafic cumulates are divided into two pyroxene gabbronorite and two pyroxene-quartz-diorite. Field evidences suggest that Pattan complex was emplaced along pre-existing metamorphosed kayal cumulate complex. The top of the Pattan complex is marked by a spectacular, intrusive polymagmatitic breccia. In Duber and NW of Duber Pattan complex is overthrusted onto the Jijal complex, which is also a layered cumulate complex. While in Pattan area and SE of Pattan there is a faulted (strike slip) contact between Pattan complex and Jijal complex. The Jijal complex is southernmost, layered ultramafic-mafic cumulate complex of the Kohistan-Ladakh tectonic province. The Main Mantle Thrust (MMT) is the southern boundary of the Jijal complex, which interns is the southern boundary of Kohistan Arc complex. The Main Mantle Thrust (MMT) Duber Thrust Fault wedges out Jijal complex NW of Duber near Chert. On the other hand Main Mantle Thrust and Pattan Fault (strike slip fault) wedges out the Jijal complex on the eastern side near Pashto. The Jijal and Pattan complexes are generated by precipitation from subduction generated, hydrous, low K, picritic high Mg tholeiitic magmas and there is a strong possibility of finding economic metallic mineral deposits with in these layered cumulate complexes.
Key words: Petrology, ultramafics, Jijal complex, Pattan complex, Kohistan.

Y/16. Yasir, M. & Anwar, M.K., 2000. General geology of northeastern Peshawar Basin, south and southeast of Swabi area. M.Sc. Thesis, University of Peshawar.

Key words: Geology, Peshawar basin, Swabi

Y/17. Yeats, R.S., 1982. Neotectonic setting of the southern Himalaya, Northern Pakistan. Abstracts with Programs, Geological Society of America 14, p.650.

Key words: Neotectonics, Himalaya.

Y/18. Yeats, R.S., 1993. Earthquake Hazard of the Himalayan Front. Abstract, Volume, 8th Himalaya-Karakoram-Tibet Workshop, Vienna, p.55.

Great earthquakes of M>8 struck the Himalayan front of India and Nepal in 1897, 1905, 1934, and 1950, leaving seismic gaps between the 1934 and 1905 earthquakes and west of the 1905 shock that were only partially filled by earthquakes in 1803, 1833, 1869, and 1991. None of these great earthquakes has any documented surface rupture, although the 1905 event was accompanied by growth of folds at the Himalayan front.
However, there is abundant evidence of young folding and faulting, including back-thrusting, and these structures must be the surface expression of a décollement moving unmetamorphosed strata over the Indian shield. Beneath much of the Sub-Himalaya, the décollement is too shallow and thus too weak to generate M>8 earthquakes, and the source must then be farther north, perhaps as far north as directly beneath the MCT, where the décollement may enter basement rocks. A major problem is the geological evidence for earthquake segment boundaries. These may follow Indian-shield discontinuities like the Hardwar Ridge and may be expressed at the surface by changes in tectonic style from imbricate thrusting to blind thrusting and development of duns. A second problem is the absence of evidence for great earthquakes prior to 1897. Civilized societies in the plains south of the Himalaya apparently did not record great events for the preceding 2000 years. On the other hand, the Taxila earthquake of A.D.25 in the northern Potwar Plateau of Pakistan may have been a great earthquake, and seismic risk to northern Pakistan may be as great as it is farther east despite the presence of Precambrian salt at the décollement farther south. The absence of Precambrian salt in Hazara and in ranges around the Peshawar basin suggests that the Precambrian salt basin terminates northward in the Himalayan foothills and therefore does not lessen seismic risk in Pakistan.
Key words: Hazards, earthquake, India, Nepal, Himalaya.

Y/19. Yeats, R.S. & Hussain, A., 1982. Zone of Late Quaternary deformation in the southern Peshawar Basin, Pakistan. In: Malinconico, L.L. & Lillee, R.J. (Eds.), Tectonics of Western Himalaya. Geological Society of America, Special Paper, 232, 265-274.

Four left-stepping pressure ridges extend for nearly 60 km parallel and close to the southern margin of the Peshawar basin, cutting diagonally across older imbricate thrust structures of the Attock-Cherat Range. Lacustrine, fluvial, and alluvial-fan deposits dated at 2.8 to 0.6 Ma are strongly folded, faulted, and eroded prior to deposition of alluvial-fan gravels, which are themselves cut by east-northeast-trending faults with their north sides up thrown. The pressure ridges postdate some of the fan drainage but deflect other drainage. The east-northeast-trending faults are high-angle and accompanied by Instrumental seismicity; there is no evidence for strike-slip except for the enechelon distribution of the ridges and low-angle slickensides on one of the faults.
Alluvial-fan and fluvial sediments are folded and faulted at Tarbela Dam, 40 km east-northeast of the easternmost pressure ridge, and the base of Indus River gravels is apparently displaced by a reverse fault with the northwest side up, Farther north, a fault adjacent to Tarbela Lake has left lateral displacement. Additional lineation and south facing scarps occur throughout the Attock-Cherat Range, and Jurassic limestone is faulted over gravels at the western end of the Nizampur basin. We interpret these features as part of a broad zone of deformation involving seismgenic crust; direction of slip is south-southwest. There is no evidence of surface rupture in this zone during Holocene time.
Key words: Peshawar basin, Late Quaternary, deformation.

Y/20. Yeats, R.S. & Hussain, A., 1987. Timing of structural events in the Himalayan foothills of north-western Pakistan. Geological Society of America Bulletin 99, 161-175.

The Attock-Cherat Range forms the southern boundary of the Peshawar basin and includes rocks transitional between metasediments of the Lesser Himalaya and foreland-basin strata to the south. The Attock-Cherat Range comprises three fault-bounded structural blocks which are, from north to south, (1) Precambrian metaclastic strata overlain by unfossiliferous limestone which is itself apparently overlain by Paleozoic strata with the contact not

exposed; (2) unfossiliferous flysch of Precambrian(?) age overlain by Cretaceous and Paleogene marine strata and Murree red beds at least in part of early Miocene age; and (3) unfossiliferous limestone, argillite, and quartzite correlated in part to Paleozoic strata in the Peshawar basin, overlain by a Tertiary sequence generally similar to that in block 2. Farther south, in the Kala Chitta Range, strata of Triassic to Eocene age occur in south-verging folds and thin thrust sheets. The similarity of the Tertiary sequences in the Kala Chitta Range and in blocks 2 and 3 demonstrates that the pre-Tertiary sequences were juxtaposed by faults prior to deposition of the Paleocene Lockhart Limestone. This may coincide with initial contact of the west-northwest-facing passive margin of India with Eurasia or nearby microplates. Major late Tertiary imbricate thrusting and folding took place prior to uplift of the Attock-Cherat Range and to deposition of Peshawar intermontane basin fill of Pliocene-Pleistocene age. The Peshawar basin formed as the Kala Chitta Range was faulted south on the Main Boundary thrust (MBT), forcing Siwalik foreland basins still farther south. Late Quaternary deformation in the southern Peshawar basin occurred along a seismically active zone of *en echelon,* stepped-left faulted pressure ridges that may reflect a subsurface ramp on the older MBT.
Key words: Structure, Himalayan foothills, Attock-Cherat Range.

Y/21. Yeats, R.S. & Hussain, A., 1989. 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 Himalaya 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: Structure, stratigraphy, Peshawar basin.

Y/22. Yeats, R.S. & Hussain, A., 1993. Geology of the Himalayan foothills from the perspective of the Attock-Cherat Range. Abstract, Volume, 8th Himalaya-Karakoram-Tibet Workshop, Vienna, p.56.

The Attock-Cherat Range contains boundaries between very different pre-Mesozoic terranes. South of the Hissartang thrust, the Kala Chitta Range and Potwar Plateau foreland fold-thrust belt comprises an unmetamorphosed Phanerozoic sequence with Ordovician to Carboniferous missing; Indian-shield rocks are overlain by Eocambrian evaporites. This correlates easily with subsurface cratonic rocks of the Punjab plains south of the Salt Range. North of the Khairabad (Panjal) thrust, late Precambrian continental-margin elastics (Manki Slate, Tanawal Quartzite) are overlain by a relatively complete Paleozoic and Mesozoic section which does not correlate well with the shield but is similar to sequences in Kashmir and Afghanistan. These strata are metamorphosed and intruded by granitic rocks, and they can be mapped northward across the Peshawar basin and Swat to the suture zone (MMT). Between the Khairabad and Hissartang thrusts are two problematical thrust plates. The northern plate is dominated by a late Precambrian flysch sequence (argillite, sandstone, and rare limestone, very weakly metamorphosed) named the Dakhner Formation; this is traced NE into the Hazara Formation. The Dakhner resembles the more highly metamorphosed Manki Slate farther north, but it lacks counterparts to the Tanawal Quartzite, Shahkotbala Limestone, Uch Khattak Limestone, and Shekhai Limestone characteristic of the Precambrian north of the Khairabad thrust. The fossiliferous Lower Paleozoic sequence overlying the Precambrian of the Peshawar basin is absent south of the Khairabad thrust, where the Dakhner is overlain directly by Paleocene strata and locally by Jurassic or Cretaceous rocks. Similar relationships are seen in the Kherimar Hills and Hazara. The southern thrust sheet consists of Darwaza Limestone, Hissartang Quartzite and associated redbeds, and Inzari Limestone overlain by Paleocene. The Darwaza to Inzari sequence lacks fossils and does not correlate easily with

the lower Paleozoic of the Peshawar basin or with any other sequence, including that of the Salt Range. The Mesozoic and Tertiary of these thrust sheets correlate with the fold-thrust belt to the south even though the older rocks do not, indicating that the Dakhner, Darwaza-Inzari, and Kala Chitta sequences were juxtaposed in pre-Paleocene and possibly pre-Jurassic time. The lack of evidence for Eocene collision suggests that the major encounter of the Attock-Cherat Range was between India and one or more microplates, and this encounter may have been largely strike slip on the western margin of the Indian plate.
Key words: Structure, Attock-Cherat, Himalayan foothills.

Y/23. Yeats, R.S. & Lawrence, R.D., 1984. Tectonics of the Himalayan Thrust Belt in Northern Pakistan. In: Haq, B.U. & Milliman, J.D. (eds.), Marine geology and oceanography of Arabian Sea and Coastal Pakistan. Van Nostrand Reinhold, New York, 177-198.

Key words: Tectonics, Himalayan Thrust belt.

Y/24. Yielding, G., Ahmad, S., Davison, I., Jackson, J.A., Khattak, R., Khurshid, A., King, G.C.P. & Zuo, L.B., 1984. A microearthquake survey in the Karakoram. In: Miller, K.J. (ed.), The International Karakoram Project, Volume 2, 150-169. Cambridge University Press.

A portable seismic network was operated in the Karakoram area of northern Pakistan for over two months during the summer of 1980. The principal objectives were to record possible subcrustal earthquakes beneath the Karakoram Range, and to monitor crustal activity throughout northernmost Pakistan. Of the 371 earthquake locations presented here, about tow-third lie in the Hindu Kush intermediate-depth seismic zone. One intermediate-depth earthquake (at a depth of about 140-km) was recorded from beneath the Karakoram Mountains. Shallow crustal activity also occurs in the Karakoram Range, with events recorded from near the northwest end of the Karakoram Fault and near a number of smaller lineaments in Baltistan. Seismicity in Kohistan appears to be largely confined to the upper crust, thought occasional earthquakes at 65-km depth (approximately the base of the crust) occur beneath areas of higher top0rgraphy (Nanga Parbat, Rakaposhi). An area close to the Hamran (1972) and Darel (1981) earthquakes showed intense activity in depth range 0-20 km, similar to that involved in the main shocks themselves.
Key words: Seismicity, earthquakes, Karakoram.

Y/25. Yin, J., 1992. Carboniferous sedimentary environment and tectonic setting in the western Kunlun and adjacent regions. In: Zheng, D., Zhang, Q. & Pan, y. (eds.), Proceedings of International Symposium on the Karakorum and Kunlun Mountains, 130-142. China Meteorological Press, Beijing.

This is a sedimentological account of the Carboniferous lithofacies zones in the Kunlun and adjoining areas. The deposits can be classified into mobile, sub-stable and stable types. The Early Carboniferous deposits of the mobile-type located at central belt of sedimentary basin are characterized by thick volcanic-sedimentary rock assemblages (>6000 m). The Late Carboniferous of the same belt are composed of shelf platform type sediments (<200 m). Meanwhile, the lithofacies zones belonging to sub-stable and stable type deposits occurred on both sides of the mobile type deposits belt. Regionally, the contact between Upper and Lower Carboniferous strata is conformable or disconformable. It is reasonable to presume that the sedimentary environments and tectonics settings for Early and Late Carboniferous in the studied area may be referred to as a rift and post-rift basins, respectively.
While the paper deals with areas outside the geographic limits of Pakistan, it includes a regional geological map that extends up to Punjab foredeep and is reproduced here.
Key words: Carboniferous, environment, rift basin, Kunlun, northern Pakistan.

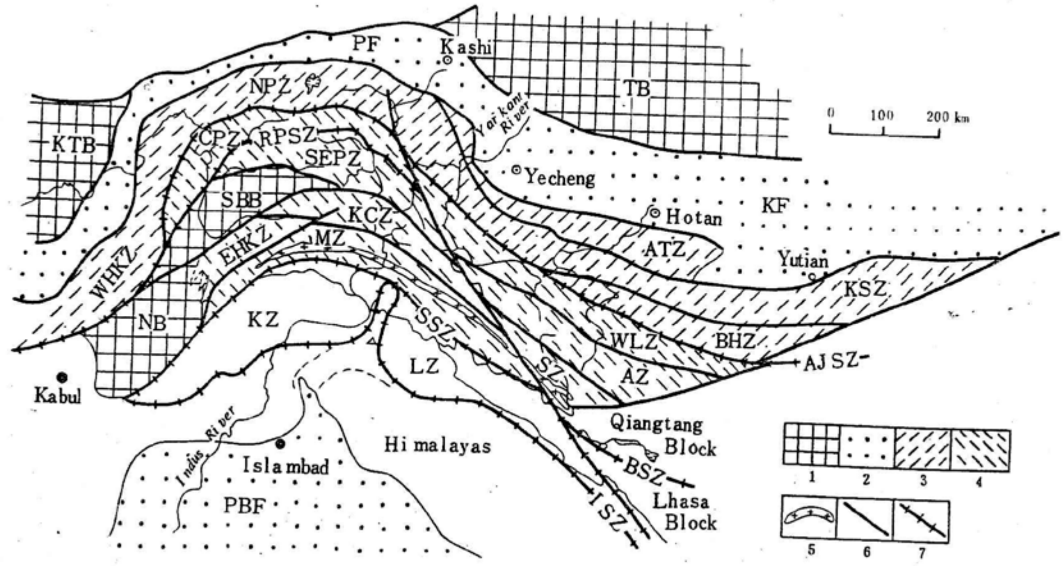

FIG.1

Schematic tectonic map of the Pamir-Western Kunlun-Karkorum regions

(Modified from Desio, 1979 and Belyaevsky, 1976)

1. Block/Massif; 2. Foredeep; 3. The Kunlun Folded System; 4. The Karakorum Folded System; 5. The Karakorum Axial Batholith; 6. Fault; 7. Suture zone. KTB: Karam-Kadjik block; SBB: South Badakhshan block; NB: Nuristan Block; TB: Tarim block; PF: Pamir foredeep; KF: Kunlun deep; PBF: Punjab foredeep. WHKZ: West Hindu Kush zone; NPZ North Pamir zone; ATZ: Akaizi-Tekelikitag zone; KSZ: Kudi-subashi zone; BHZ: Bayan Har zone (Karatag mountain). CPZ: Central Pamir zone; SEPZ: Southeast Pamir zone; KCZ: Kara Chukur zone; MZ: Muztagh zone; EHKZ: East Hindu Kush zone; WLZ: West Loqzun zone; AZ: Aghil zone; SZ: Saser zone. KZ: Kohistan zone. LZ: Ladakh zone AJSZ: Akbaital-Jinsha River suture zone; SSZ: shayok/Northern suture zone; ISZ: Indus/southern suture zone.

Y/26. Yin, J. & Bian Q., (Chief Compilers), 1996. Geological map of the Karakorum-Western Kunlun and adjacent regions. In: Pan Yusheng (ed.), Geological Evolution of the Karakorum and Kunlun Mountains. Seismological Press, Beijing, 288p.

This volume deals with stratigraphy and paleontology, characteristics of sedimentary rocks, ophiolites, geochemistry of granitic rocks, geophysics and regional geologic evolution and tectonics of the mountain region to the north of Pakistan border. The geological map, however, gives information on area as far to south as Nanga Parbat. There are brief descriptions in Chinese and English.
Key words: Mapping, stratigraphy, palaeontology, ophiolites, Karakoram.

Y/27. Yoshida, M., 1996a. Paleomagnetic synthesis of three phases collision in the Himalaya-Karakoram belt and surrounding terranes. Extended Abstracts, International Seminar on Paleomagnetic Studies in Himalaya-Karakoram Collision Belt and Surrounding Continents, November 20-21, 1996, Islamabad. Geoscience Lab, GSP, Islamabad, 23-26.

It has been widely accepted that the Himalaya-Karakoram ranges were shaped by a crustal deformation caused by the collision of the Indian subcontinent with the Eurasian continent. In the northwestern part of the Himalaya-Karakoram belt, this continent- continent collision is not simple because (1) the Kohistan-Ladakh arcs were captured between the two colliding continental blocks, Indian and Eurasia continents, and (2) on the west, the Himalaya-

Karakoram belt adjoins the Afghan block bordered by the Chaman strike-slip faults zone, which caused a complicated oblique-collisional tectonic setting of the region (Figure 1).

(1) Suturing around the Kohistan-Ladakh Arcs

The paleo-latitudinal changes for the Kohistan arc, northwestern part of Indian subcontinent (northern Pakistan), and Eurasian continent since mid-Cretaceous time are illustrated in the Figure 2.

MKT Suturing: The paleo-position of Kohistan arc in mid-Cretaceous time is estimated to be around the equatorial zone (Zaman and Torii, 1996). The paleomagnetic direction of mid-Cretaceous Kohistan rocks is quite similar to that of Cretaceous components maintained by the rocks in the immediate northern block belonging to the Eurasian continent (Klootwijk et a1., 1994; Zaman and Torii, 1996), which indicates the paleo- position of the Kohistan arc at the mid-Cretaceous time was very close to the southern margin of the Eurasian continent. The Main Karakoram Thrust zone (Northern Suture or Shyok Suture zone) had been probably already sutured. The mid-Cretaceous landmass extended from the Kohistan arc to the Karakoram block (= southern marginal terrane of Eurasian continent) was, however, considerably distant from the Eurasian inland terranes, Tadzhikistan and Tarim basins. Its latitudinal discrepancy is more than 20" (2,000 km+) despite only 2"-4" gap (several hundred kilometers) is given in present geographic frame, which suggests a remarkable crustal shortening (intra-continental subduction) along terrane-boundaries took place within the Eurasian continent. Figure 1: Geotectonic frame of the Himalaya-Karakoram collision belt and surrounding terranes (boundaries based on Jacob and Quittmeyer, 1979), and the triple collision zone.

MMT Suturing: In northern Pakistan, the India-Eurasia collision is represented by the suturing along the Main Mantle Thrust (MMT) between the Kohistan and subcontinent. According to the compilation of paleomagnetic data (paleo-latitudes), the northward movement of the subcontinent is very rapid up to around the Late Paleocene (ca.58Ma) but after that the rate of movement suddenly slowed (Figure 2). Then the discrepancy of paleo-latitudes between the northwestern margin of subcontinent and the Kohistan arc (Ahmad and Yoshida, this volume) exhibits very small in Middle Eocene time (ca.45Ma), which suggests a completion of MMT suturing. Similar evidence has been found in the paleomagnetic data of deep-sea sediments accumulated on the Indian oceanic crust (Klootwijk et a1., 1992). These sudden slowdowns in the northward motion of subcontinent are probably caused by an 'initial collision' without complete suturing along the MMT. Continuous underthrusting ('subduction' within continental crust) might occurred along the MMT suture zone in Paleocene-Eocene time. This may provoke an immense deformation of the crust of Kohistan arc including tectonic rotations and formed a structural frame of the Himalaya-Karakoram collision belt in northern Pakistan. (2) Oblique Collision between India and the Afghan Block Paleomagnetic data is sparsely known in the Afghan block which is of fused micro-continent terranes such as Helmand, Lut and Kabul blocks. Paleomagnetic data obtained from the Chagai and Raskoh volcanic arcs, southern part of the Afghan block mark its paleo-position in Paleogene time. The India-Afghan suturing is considered to be an oblique collision in Pliocene (Treloar and Izatt, 1993). The collision corresponds to a reorganization of arc-subduction system around the Afghan block which is represented by the calc-alkaline volcanism in the Sultan arc since the Gilbert Chron (Akram and Yoshida, 1996). The tectonic rotation within the block after the India-Afghan collision is also unveiled by the paleomagnetic data.

(3) Triple Collision Zone

The Himalaya-Karakoram collision belt is therefore characterized as a triple collision zone. Three phases of collision (Treloar and Izatt, 1993) can be, at least, recognized in and around the Himalaya-Karakoram collision belt, northwestern Pakistan since Cretaceous time. The first collision is represented by the MKT (or Shyok) suturing occurred in the Early (?) Cretaceous. The second collision is India-Eurasia collision which occurred along MMT (Indus-Tsangpo) suture at Late Paleocene-Middle Eocene time. The third one is the oblique collision between the collage of India-Kohistan terranes and the Afghan block. On the basis of currently-available paleomagnetic data, terrae-scale displacement and tectonics of this triple collision zone will be synthesized.

Key words: Paleomagnetism, collision, Himalaya, Karakoram.

Y/28. Yoshida, M., 1996b. Multi-disciplinary study of late Quaternary Loess-paleosol deposits in Haro river area, Attock district, Punjab, Pakistan- An Overview. Proceedings of Geoscience Colloquium, Geoscience Lab, GSP, Islamabad, 14, 71-75.

This is an introduction to the Loess-paleosol deposits studied by several groups of the geoscience laboratory. The various contributions are listed in appropriate places.

Key words: Loess-paleosol deposits, Late quaternary, Attock.

Y/29. Yoshida, M., & Ahmad, M.N., 1995a. Paleomagnetism of oolitic ironstone bed in Hazara District, Northern Pakistan: Cretaceous–Tertiary Paleo–laterite in northwestern Lesser Himalaya. Nepal Geological Society Journal (Special Issue), 12, p.14.

Key words: Paleomagnetism, Cretaceous, Tertiary, Laterite, Hazara, Himalaya.

Y/30. Yoshida, M. & Ahmad, M.N., 1995b. Rock magnetic properties and Paleomagnetism of oolitic iron stone, Hazara District, northern Pakistan. In: Khadim, I.M. & Yoshida, M. (eds.), Rock Magnetism and Paleomagnetism. Recent Progress in Pakistan, Proceedings of Geoscience Colloquium, Geoscience Lab, GSP, Islamabad, 13, 59-79.

Chamosite-hematite type oolitic ironstone, the Langrial iron ore, is distributed in Hazara District, northwestern margin of Indo-Pakistan Subcontinent which is situated in the northwestern part of the Lesser Himalayan Belt. The ironstone bed is assumed to be a palm-laterite formed during Cretaceous -Tertiary (K-T) time. The oolitic ironstone bed induces a geomagnetic anomaly with a maximum anomalous intensity of c.5OOnT; and no meaningful anomaly pattern was observed by VLF-EM survey. The oolitic ironstone shows rather small magnetic susceptibility and relative weak NRM intensity but very hard coercivity. Ferromagnetic properties of the rock are mainly derived from hematite grains which possess two remanence component: the overprint component (Declination=83.6", Inclination=27 7") and the characteristic remanence component (DecWon=298.5", Inclm~tion=l9.8~). The directions of these remanence components suggest two-phase clockwise tectonic rotation of the terrain after the acquisition of each remanent magnetization. The characteristic component probably indicates paleomagnetic direction during the formation of oolitic ironstone which is inferred to be a lateritization and erosion processes at Cretaceous-Tertiary (K-T) boundary time in the southern hemisphere. The overprint.component which passed a reversal test was possibly a thermo-viscous remanent magnetization (TVRM) acquired by long-term burial heatmg due to a subsidence of the terrain in the northern hemisphere.
Key words: Paleomagnetism, ironstone, Hazara.

Y/31. Yoshida, M., Ahmad, M.N., Ali, M. & Khadim, I. M., 1993. Paleomagnetic study of Kalam volcanics, upper Swat valley, northern Pakistan. 1993 Fall Mtg. The Society of Geomagnetism and Earth Planetary, and Space Sciences (SGEPSS), Abstract C 12, P1–08.

Key words: Paleomagnetism, volcanics, Kalam, Swat.

Y/32. Yoshida, M., & Fujiwara, Y. 1994a. Rock magnetic studies in Pakistan. In: Magnetic approaches to Geological Sciences, Part III. (Yoshida, M. & Fujiwara, Y. eds.,) Geoscience Labs. Geological Survey of Pakistan, Islamabad.

Rock magnetic study in Pakistan has been attempted on the rocks in the northern area for structural and geomagnetic analyses. Here, selected typical studies: rock magnetic studies in Hazara-Kashmir Syntaxis (Bassart et al, 1990), AMS studies on Jijal and Chilas complexes (recent studies by Geoscience labs. Project), and magnetic susceptibility study in northern Pakistan, are reviewed.
Key words: Magnetic studies, Hazara-Kashmir.

Y/33. Yoshida, M., & Fujiwara, Y. 1994b. Paleomagnetic studies on Siwaliks in Pakistan. In: Magnetic approaches to Geological Sciences, Part III (M. Yoshida & Y. Fujiwara, eds.), Geoscience labs. Geological Survey of Pakistan, Islamabad.

The Siwaliks of the Potwar Plateau, northern Pakistan, present the best example of a continuous sequence of paleomagnetically well-dated terrestrial deposits spanning most of the Neogene. In this work, magnetostratigraphy and some environmental analyses of Siwaliks are reviewed.
Key words: Paleomagnetism, magnetostratigraphy, Siwaliks, Potwar Plateau.

Y/34. Yoshida, M., & Fujiwara, Y. 1994c. Paleomagnetic studies in Pakistan. In: Magnetic approaches to Geological Sciences, Part III (M. Yoshida & Y. Fujiwara, Eds.), Geoscience labs. Geological Survey of Pakistan.

Palaeomagnetic studies in Pakistan and its adjacent area have been carried out in various fields: paleogeography, continental drift, crustal deformation, magnetostratigraphy, and tectonic interpretation in the late Proterozoic and the Phanerozoic. Here, previous achievements except on the Siwaliks (see Y/30) are summarized and recent studies by the Geoscience Labs project are discussed.
Key words: Paleomagnetism, magnetostratigraphy, tectonics, Proterozoic, Phanerozoic.

Y/35. Yoshida, M., Karim, T. & Zafar, M., 1996. Thorium–232 decay series anomaly in natural Gamma–ray spectra of Haro river Loess–Paleosol deposits, Attock district, Punjab. Geological Survey of Pakistan, Proceedings Geoscience Colloquium, 14, 129–138.

Late Quaternary loess-paleosol sequence of Ham river sections, Attock, Punjab, exhibits a spectral gamma-ray anomaly in the energy window t (2.45-2.79MeV) which represents the thorium-232 (^{232}Th) decay series. The horizons showing high Th anomaly are probably enriched in Th-bearing minerals such as monazite. The anomalous horizons also coincide with the beds of Au concentration which is of placer origin. It suggests that the spectral gamma-ray method can be applicable to explore placer gold in the area.
Key words: Paleosole, Quaternary, Thorium^{232} decay, Attock.

Y/36. Yoshida, M., Khan, I.H. & Ahmad, M.N., 1996. Rock magnetic interpretation on the origin of Paleogene oolitic iron stone, Langrial iron ore, northern Pakistan. Extended Abstracts, International Seminar on Paleomagnetic Studies in Himalaya-Karakoram Collision Belt and Surrounding Continents, November 20-21, 1996, Islamabad. Geosciences Lab, GSP, Islamabad, 116-119.

Key words: Paleomagnetic properties, ironstone, oolitic, Hazara.

Y/37. Yoshida, M., Mononobe, S. & Karim, T., 1992. Thermomagnetic properties of Iron Titan oxides in the “hematite band”, Abbottabad area (a short note). Geological Survey of Pakistan, Proceedings of Geoscience Colloquium 3, 23-27.

This account gives thermomagnetic properties of the Fe-Ti oxides in oolitic hematite band at the K-T Boundary near Bagnoter, Abbottabad.
Key words: Thermomagnetism, haematite, Abbottabad, Hazara.

Y/38. Yoshida, M., Zaman, H. & Ahmad, M.N., 1996. Paleoposition of Kohistan arc and surrounding terrane since Cretaceous time: the paleomagnetic constraints. In: Kausar, A.B. & Yajima, J. (eds.), Geology, Geochemistry, Economic Geology and Rock Magnetism of the Kohistan Arc. Proceedings of Geoscience Colloquium, Geoscience Lab, GSP, Islamabad 15, 83-101.

Paleomagnetic data recently obtained from the rock units in Kohistan arc show considerably tow palm-latitude at early Tertiary and mid-Cretaceous times. Palmmagnetic data of the Indo-Pakistan subcontinent, palm-latitude data of Indian deep- sea sediments, and sea-floor spreading data of the Indian Ocean have detailed the southern limit of the Kohistan arc for the past 80 m.y. Palmmagnetic data from the Tadzhikistan and Tarim basins of Eurasian continent blocks, also reveal the northern limit of the arc and lateral displacement of southern continental margin.

Analysis of the combined paleolatitude-age profiles for these terranes (Figure 6) indicates paleomagnetic constraints on paleoposition of the Kohistan arc and its collision timing.
Key words: Paleomagnetism, Cretaceous, Kohistan arc.

Y/39. Yoshida, M., Zaman, H., Khadim, I.M., Ahmad, M.N. & Akram, H., 1997. Paleoposition of the Himalaya-Karakoram belt and surrounding terrans since Cretaceous: Paleomagnetic reconstruction of three phases collision history. In: Khadim, I.M., Zaman, H. & Yoshida, M. (Eds.), Paleomagnetism of Collision Belts. Geoscience Laboratory, GSP, Islamabad, 49-72.

Paleomagnetic data recently obtained from Pakistan have made conceivable a history of three phases collision of the Himalaya-Karakorarm collision belt and surrounding terranes since Cretaceous time. The early Cretaceous was the time of suturing between the Kohistan arc and the Asian continent. At that time Indo-Pakistan subcontinent was located far in the southern hemisphere and the southern margin of the Asian continent spread out around equatorial region. The southern margin of Asian continental block was continuously shifting northward during the Cretaceous period after the Asia-Kohistan collision. The Paleocene was the main collisional stage between the Indo-Pakistan subcontinent and Kohistan-Asia blocks. The collision caused gigantic deformation and crustal shortening in and around the Himalaya-Karakoram collision belt. Most of ophiolite blocks around the subcontinent (peri-Indian suture) were obducted during this stage of time. Suturing between Indian subcontinent and Asia-Kohistan block was followed by the oblique collision between Indian subcontinent and Afghan block to the west, which provoked large-scale counterclockwise rotation by the late Eocene to early Oligocene. Thus, analysis of the combined paleolatitude-age profiles and paleomagnetic investigation of the tectonic deformation for these terranes document the geohistory of three phases collisions of the Himalaya-Karakoram collision belt: the first phase Asia-Kohistai collision (along the Shyok Suture) in the early Cretaceous, the second phase Kohistan-India collision (along the Indus-Tsangpo Suture) in the Paleooene, and the third phase India-Afghan block (along the Chaman Strike-Slip Fault) collision in the late Eocene-early Oligocene.
Key words: Paleomagnetism, Cretaceous, Karakoram, Kohistan arc.

Y/40. Yoshino, T., 1998. Magmatic underplating of the lower crust of the Kohistan arc (N. Pakistan) deduced from Al-zoning in clinopyroxene and plagioclase. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop, 220-221.

The Kohistan complex, lying in the north-western part of the Himalaya, has been considered as a Cretaceous magmatic island arc, namely the Kohistan arc. The complex displays a widely exposed lower crustal section composed of metabasic rocks (amphibolites, pyroxene granulites and garnet granulites) with gabbroic origin. Because the lower crust of the Kohistan arc commonly has a mafic composition derived from gabbroic magma, magmatic underplating should be considered as a crustal generation mechanism. During the period of subduction-related magmatism, the underplated materials at middle to deep crustal level could subsequently undergo metamorphism under high-T conditions corresponding to upper amphibolite to granulite facies. Hence metabasites derived from a gabbroic protolith of the lower crust might preserve information of the metamorphism after cooling from magmatic temperature. Metamorphic P-T paths of the rocks would provide a constraint on the overall history of crustal evolution.
The lower crustal part of the Kohistan arc is devided into three geological units: the Jijal complex, the Kamila amphibolite belt and the Chilas complex, from south to north. Yamamoto. proposed a tectonic thickening model on the basis of two contrasting P-T paths of garnet-bearing granulites in the Chilas and Jijal complexes. The P-T path of the Chilas complex involved approximately isobaric cooling at relatively low-pressure conditions, whereas that of the Jijal complex showed anti-clockwise path at higher-pressure conditions. Such anti-clockwise P-T paths may reflect crustal thickening due to magmatic underplating or accretion in the crust. It is insufficient, however, to consider models for these P-T paths, because the P-T path for rocks of the Kamila amphibolite belt, which is sandwiched by the Chilas and Jijal complexes, has not documented well. To understand the evolutional process of the lower crust of the Kohistan arc, determination of P-T paths of the Kamila amphibolite belt is needed.
The lower crustal rocks of the Kohistan complex (northern Pakistan) are mostly composed of metabasic rocks such as pyroxene granulites, garnet granulites and amphibolites that were originally gabbros. P-T trajectories of the relic

two-pyroxene granulites, which are the protolith of the amphibolites within the Kamila amphibolite belt have been investigated. Aluminous pyroxene retains igneous texture such as exsolution lamellae developed at core. The significant amount of Al in clinopyroxene is buffered by breakdown reactions of plagioclase accompanied by film-like quartz as a product at grain boundaries between plagioclase and clinopyroxene. Distinct Al-zoning profiles are preserved in pyroxene with exsolution lamellae at core and plagioclase adjacent to clinopyroxene in pyroxene granulites. In the northern part of the Kamila amphibolite belt, Al-contents in clinopyroxene increase toward the rim and abruptly decrease at the outer rim, and anorthite contents in plagioclase decrease toward the rim and abruply increase near the grain boundary between plagioclase and clinopyroxene. In the southern part of the Kamila amphibolite belt, Al-contents in clinopyroxene and anorthite contents in plagioclase simply increase toward margin of the grain. The anorthite zoning in plagioclase is in agreement with the zoning profiles of Ca-tschermaks and jadeite components inferred from variations of Al, Na, Ti and Fe3+ in clinopyroxene. Assuming that the growth surface between them was in equilibrium, geothermobarometry based on Al-zoning in clinopyroxene coexisting with plagioclase indicates that metamorphic pressures significantly increase with increasing temperature under granulite facies metamorphism. The peak of granulite facies metamorphism occurred at conditions of about 800 ^{0}C and 800-1100 MPa. These prograde P-T paths represent a crustal thickening process of the Kohistan arc during the Early to Middle Cretaceous. The crustal thickening of the Kohistan arc was caused by accretion of basaltic magma at mid-crustal depth.
Key words: Magmatism, mineral chemistry, Cretaceous, Kohistan arc.

Y/41. Yoshino, T., Yamamoto, H., Okudaira, T. & Torium, M., 1998. Crustal thickening of the lower crust of the Kohistan arc (N.Pakistan) deduced from Al zoning in clinopyroxene and plagioclase. Metamorphic Geology 16, 729-748.

The lower-crustal rocks of the Kohistan complex (northern Pakistan) are mostly composed of metabasic rocks such as pyroxene granulites, garnet granulites and amphibolites. We have investigated P-T trajectories of the relic two-pyroxene granulites, which are the protolith of the amphibolites within the Kamila amphibolite belt. Aluminous pyroxene retains igneous textures such as exsolution lamellae developed in the core. The significant amount of Al in clinopyroxene is buffered by breakdown reactions of plagioclase accompanied by film-like quartz as a product at grain boundaries between plagioclase and clinopyroxene. Distinct Al zoning profiles are preserved in pyroxene with exsolution lamellae in the Kamila amphibolite belt, Al in clinopyroxene increases towards the rim and abruptly decreases at the outer rim, and anorthite in plagioclase decreases toward the rim and abruptly increases near the grain boundary between plagioclase and clinopyroxene. In the southern part of the Kamila amphibolite belt, Al in clinopyroxene and anorthite in plagioclase simply increase towards the margins of the grains. The anorthite zoning in anorthite in plagioclase simply increase towards the margins of the grains. The anorthite zoning plagioclase is in agreement with zoning profiles of Ca-Tschermks and jadeite components inferred from variations of Al, Na, Ti and Fe^{3+} in clinopyroxene. Assuming that the growth surface between them was in equilibrium, geothermobarometry based on Al zoning in clinopyroxene coexisting with plagioclase indicates that metamorphic pressures significantly increased with increasing temperature under granulite facies metamorphism. The peak of granulite facies metamorphism occurred at conditions of about 800 ^{0}C and 800-1100 Mpa. These prograde P-T paths represent a crustal thickening of the process of the Kohistan arc during the Early to Middle Cretaceous. The crustal thickening of the Kohistan arc was caused y accretion of baslatic magma at mid-crustal depths.
Key words: Crustal thickening, granulites, amphibolites, mineral chemistry, Kohistan arc.

Y/42. Young, G.J., 1982. Glaciological Data Report GD 12 - Glacial Hydrology. World Data Center-A for Glaciology [Snow and Ice], Boulder, Colorado. 133p.

Key words: Glaciology, hydrology.

Y/43. Young, G.J. & Hewitt, K., 1993. Glaciohydrological features of the Karakoram Himalaya: measurement possibilities and constraints. In: Young, G.J., (ed.), Snow and Glacier Hydrology. International Symposium, Kathmandu, Nepal, 16-21 November 1992. Proceedings. International Association of Hydrological Sciences. IAHS/AISH Publication. 218: 273-283.

Key words: Glaciology, Hydrology, Karakoram.

Y/44. Young, G.J. & Schmok, J., 1989. Ice loss in the ablation area of a Himalayan Glacier: studies on Miar Glacier, Karakoram Mountains, Pakistan. Annals of Glaciology 13, 289-293.

One of the main aims of the Snow and Ice Hydrology Project, a joint Canada-Pakistan endeavor, is to estimate ice loss in the ablation areas of glaciers in order to predict with greater confidence stream flow in the headwaters of the Indus River. To this end, Miar Glacier, located in the central Karakoram Range, north of Gilgit, was intensively studied during the summers of 1986 and 1987. Measurements of glacier mass balance by the monitoring of accumulation and ablation at stake locations is very difficult in the Himalayan environment. It is usually almost impossible to reach elevations above the equilibrium line without major effort, and always very difficult once there to make meaningful measurements; the ablation areas are often heavily crevassed and/or debris-covered, and this poses difficult sampling problems. The method used in this study was to monitor annual surface movement on a cross-profile as near as possible to the equilibrium line. The measurements, obtained in conjunction with depth soundings made on the same profile, allow the annual ice flux through the cross-profile to be calculated. If an approximately steady-state glacier is assumed, it would be expected that this flux would be roughly equivalent to the rate of ice loss below the profile. The movements of wooden stakes drilled into the glacier were monitored throughout each of the summers and, since two of the stakes survived the intervening winter, this allowed calculation of annual movement. Distances between the crests of ogives were also surveyed, providing an independent assessment of glacier movement. Depth measurements by radio-echo sounder were successfully made in the summer of 1987, showing maximum ice depths of 550 m. The annual ice flux through the transverse profile was estimated as 5.67 x 107 m3, which corresponds to a mean annual ice loss from the glacier surface below the profile of 8.10 m of ice.
Key words: Glaciology, hydrology, ablation, Miar glacier, Indus River, Karakoram.

Y/45. Young, H.L., 1964. Geohydrology of Naranji area, West Pakistan. Preliminary Report 3, Water and Soil Investigation Department Publication 32, Hydrogeology Directorate, WAPDA, North West Frontier Province, Peshawar.

Key words: Geohydrology, Naranji, Peshawar.

Y/46. Young, H.L. & Naqavi, S.A.H., 1964. Geohydrology of the Dharmrah Kas area, Preliminary Report 9, Water and Soil Investigation Department Publication 37, Hydrogeology Directorate, WAPDA, North West Frontier Province, Peshawar.

Key words: Geohydrology.

Y/47. Younghusband, F.E., 1895. Chitral, Hunza and the Hindu Kush. Geographical Journal, London. 5(5), 409 – 422

<u>As this article does not have an abstract, the first few paragraphs are reproduced here:</u> It is with a good deal of compunction that I address you on these states of the Hindu Kush which are to form the subject of my lecture to-night, for I feel that the honour of doing so should have fallen on others than myself. I was not the first, by many, to explore and open up these states. Many had gone before me, and all that I could do ras to follow in the steps of these first pioneers, and carry on the work which they had commenced. Poor Hayward, the first intrepid Englishman who pushed his way into these mountain recesses, never returned to tell the tale of what he saws for he was cruelly murdered in Yasin in 1870. But Biddulph, the first to visit Chitral and the first to visit Hunza, might well have borne the privilege which is now falling to me. And Macnair, Sir William Lockhart and the members of his mission Mr. Ney Elias, Colonel Durand, Dr. Robertson, Captain Tyler, E.E., were all my predecessors, and could have told a more interesting tale than mine of how they found these primitive, picturesque hill-men at their very first touch with the outside world. But while I cannot lay claim to your attention as the first to visit this interesting region, I can, at least, ask it as the last to do so. It has been my privilege to represent the British Government in both Hunza and Chitral, and it is only a few months ago that I returned from the latter place, after a stay of more than two years

among these little states of the Hindu Kush. Before, however, proceeding to any description of theses it is necessary for me to put clearly before you the reasons why these regions should especially interest you. These are many. There are, first, the political and military reasons. Here is the point where, as the title of Mr. Linight's remarkably interesting book runs, ' Three Empires Meet.' The Indian, the Russian, and the Chinese empires all meet here, and where three such empires meet the eyes of the people who inhabit them must naturally be turned. To the members of a scientific society, however, such considerations may possibly not have much weight. These would require some deeper attraction than the mere political boundaries of different races. To such the Hindu Kush affords the highest interest; for we have here mountain ranges of colossal height and only of recent years explored, and races of people of a very primitive type, who, shut up for centuries in their mountain fastnesses, have preserved intact much of their original type of manners and customs. I was brought up a soldier, and became a " political," as we are called in India, my interests were therefore more purely military and political rather than scientific; but as it was a part - the main part, I may say- of my duties to study the character and nature both of the people and the country, I shall hope that some of the impressions I formed of them may prove interesting to you. The country I am to describe to you, then, is that lying immediately north of Kashmir and south of the Pamirs, which is drained by water flowing into the Indus, and comprises the states of Hunza, Nagar, and Chitral. It is an entirely mountainous country, with never a stretch of plain mole than 3 or 4 miles in length. The valleys are all deeply cut, and even the longest mountains are 13,000 or 14,000 feet in height, while some rise to 25,000. The nature of the mountains will best be gathered from the lantern slides I propose to show you. Except in the lower part of Chitral and in occasional secluded side valleys, they are perfectly bare. In some parts one may travel for March after march without seeing a sign of a tree outside the valley bottoms, and the barren character of these hills has much to do with their forms and with that of the valleys. What we see here are great masses of rocky mountains, their summits in the loftier regions clothed in snow and ice, but in most parts bare, and their bases always so. On these rocks the sun in summer beats down with a force which makes them so hot it is impossible to keep one's hand on them without burning it; and in winter come frosts reaching below zero Fahrenheit, which freezes the draining of the snow and rain in the crevices of the rocks, and breaks them off by the same process as water swollen into ice bursts up our water pipes. Owing to the extremes of temperature, the rocks in all this region are very loose, so when the snow melts off them at the close of winter and still more so when a storm of rain or a cloud-burst falls upon these mountains, the whole of them sides is washed of their loose debris, which comes pouring down a liquid stream of mud and stones and boulders into the gorges, and there piles itself up till, by the pressure of weight from behind it is forced out into the more open main valley and then spreads itself out in one of those alluvial fans, or cones de dejection which occur in all mountainous countries, but which are seen in these dry lofty regions of the Hindu Kush in their fullest development These are one of the most characteristic features of this country, and it is for this reason that I direct your attention to them. The traveller here sees in the distance some big snowy peak, but the greater part of the scene around him is of bare hillside, and the valley bottoms, which to traverse are simply a succession of these alluvial fans separated here and there by some huge rocky bluff, but often running one into the other in a continuous stretch. The climate of these regions is one of extreme. At Chitral (5000 feet) the maximum I registered was 100°, and at Gilgit (4800 feet) Dr. Roberts recorded a maximum of 110°. These temperatures were in the cultivated parts, where the vegetation makes it cooler. In the bare open valley, where the sun comes with full force on the rocks, it must be certainly greater. As to the minimum, in Chitral in February (I have no January records) the lowest reading was 15°, and in Mastuj (7800 feet) 5° below zero. In Gilgit it is not so cold; the thermometer there does not appear to fall below 20°. The air over most of the region is extremely dry and the rainfall very small. Nearly all the 2 E 9 moisture from the monsoons, which break over the plains of India, is precipitated on the outer ranges of mountains before reaching these remote valleys; and, though not so dry as the countries east and north for a certain amount of moisture seems to come up the funnel of the Indus valley to Gilgit and Hunza, and over the Bajaur hills to Lower Chitral-the rainfall on the whole is very slight, and the climate dry and healthy.

Key words: Geography, climate, Chitral, Hindulush, Hunza.

Y/48. Younghusband, F.E., 1896. The Heart of a Continent. Murray, London. Reprinted 1984, Oxford University Press, Oxford, 409p.

Key words: Books, Continents.

Y/49. Yousaf, M., 1970. Gravity survey of Kohat Area. M.Sc. Thesis Institute of Geology, Punjab University, Lahore, 87p.

The gravity survey of Kohat area has been conducted in Collaboration with Gravity Party III of Oil and Gas Development Corporation, for the purpose of oil prospecting. A network of 562 ordinary gravity stations and 15 gravity base stations covering an area of about 5000 sq. Km was accomplished. The survey consisted of geodetic work and gravity observations carried out with a Russian transit theodolite and Wordon gravimeter respectively. The results of the survey are shown on a Bouguer anomaly map on the scale of 1: 250,000 which show a number of positive and negative anomalies both qualitative and quantitative analysis of this map has been done.
Key words: Gravity survey, Kohat.

Y/50. Yousaf, M., 1979-81. Lithostructural mapping of Khanpur Dam Project Area with special reference to the engineering geological problems at the dam site. Punjab University, Lahore.

Key words: Hydrology, engineering geology, Khanpur dam, Haripur.

Y/51. Yousaf, M., 1987-89. The geology and petrology of Jijal and Patan complexes southeast of Indus River in southern Kohistan. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 80p.

The project area lies in some parts of Kohistan and Mansehra districts, covering about 150 sq. kms area, including south castera sides of Jijal and Patan complexes, starting from Karakoram highway spreading up to Pashto village. The work has evolved geological mapping of the area on a scale of 1:50,000. This thesis deals with the geological, petrographical and petrogenetical studies of the Jijal and Patan complexes and their relation with Kayal complex. The project area Lies in the frontal part of the Kohistan island arc which covers about 36,000 sq Km urea, structurally bounded by sutures named as Main Mantle thrust (MMT) and Main Karakorum thrust (MKT) on its southern and northern sides respectively. The Kohistan arc is intruded by a large number of basic complexes starting from a very primitive Dasu complex up to Jijal complex along with a Kohistan batholith which was intruded at last. Previously, the metamorphosed mafic complexes have been lumped together as an undifferentiated mass called Kamila amphibolite. Now we under the guidance of our supervisors have divided the Kamila amphibolite into three complexes starting from very older Dasu complex down to Kayal complex and last emplaced Patan complex. Dasu complex is the oldest pluton which is highly metamorphosed, intruded in the island arc. Dasu complex is underplated by another pluton the Kayal complex which is metamorphosed upto amphibolite facies grade, but less metamorphosed as compared to Dasu complex. Again Kayal complex is being underplated by another pluton which least metamorphosed last emplaced Patan complex. Patan complex is inturn underplated by a highly metamorposed Jijal complex which is being obducted nto the Indian plate. The geological rock sequences of the area consist of ultramafic and mafic associations. The ultramafic association of the Patan complex is overlain by a thick mafic unit which grades into two pyroxene diorite at top and gabbronorite at base. The ultramafic portion of the Patan complex is discovered by us for the first time which is well exposed in north western side of Indus River (in Duber stream) and is sliced off in south eastern side due to strike slip Patan fault. The ultramafic association of the Jijal complex consists of cyclic units of dunite/wehrlite-websterite-hornblende clinopyroxenite –garnet clinopyroxenite. The mafic association of Jijal complex consists of a massive garnet gabbroic unit of about 7 Km. Both Jijal and Patan complexes are interlinked by a strike-slip fault named as Patan fault. The field evidences reveal that both Patan and Jijal complexes are well layered intrusions emplaced in the frontal part of the island arc by underplating , phenomenon, among which Jijal complex is least metamorphosed. Both complexes were formed from two different cycles of magma which was hydrous, low K, picritic-high Mg tholeiitic in nature (Loucks, 1990).
Key words: Petrology, ultramafics, Jijal, Pattan, MMT, Kohistan.

Y/52. Yousafzai, A.K., 1997. Geology of Shamozai area in part of Bajawar Agency and Lower Dir: Implications for extensions of collision zone. M.Sc. Thesis, University of Peshawar, 46p.

Key words: Indus suture, petrology, Shamozai, Bajaur, Dir.

Y/53. Yousafzai, I.J.K., Badshah, M.A., Shah, A.A. & Ahmad, B., 1975. Petrography of the ultramafics and related rocks of Pashto and Barai area, Northeast of Shergarh-Sar Allai Kohistan Hazara. M.Sc. Thesis, University of Peshawar, 31p.

Key words: Petrology, ultramafics, MMT, Allai, Kohistan.

Y/54. Yusuf, S.M., 1961. Mineral position of Pakistan. CENTO Conference on minerals, Ankara, 28-44.

Key words: Minerals, statistics.