N/1. Nabi, S.M., 1968. Preliminary investigation of muscovite-pegmatite of Khadang Banda near Talash, Dir state, West Pakistan. Geological Bulletin, University of Peshawar 3, 12-14.

The pegmatite of Khadang Banda near Talash, Dir State, was mined by the locals for extracting muscovite. According to the information, about 15 to 20 maunds of white mica had been extracted from the pegmatite veins, which were sold at Lahore and Karachi, during the last five years. A partly M. Sc. students under the supervision of the author conducted geological investigation of this area to study the mineralization in these veins and to assess their potential for large scale economical exploitation muscovite.
Key words: Pegmatite, Talash, Dir.

N/2. Nadeem, M., Chaudhry, M.N. & Baig, M.G., 2000. Sedimentological studies of Lumshiwal Formation at Kalas, Attock Hazara fold and thrust belt, Pakistan. Abstracts, Third South Asia Geological Congress, Lahore, 64-65.

A preliminary study of facies, microfacies, diagenesis, provenance and environment of deposition of Lumshiwal Formation of Early Cretaceous age from Kalas, Attock Hazara Fold and Thrust Belt, was carried out for the first time. The objective was to study the formation in the northwestern part of the oil and gas producing Indus Basin. The formation is producing gas from Punjab Platform.
The Kalas section (Lat: 33" 02' 45" N; Long: 73' 25' 30" E) of Lumshiwal Formation near Barian is 33.55 meter thick. The formation at Kalas comprises mainly of fine to medium grained sandstone which is medium grey, light brown, medium to dark grey, light grey and greenish to medium grey on fresh surface. At places fresh surface shows greenish tinge which becomes darker green on wetting. The sandstone weathers to rusty brown, dirty grey, yellowish brown, light to medium rusty brown , dark brown and greenish grey.
The Kalas section of Lumshiwal Formation comprises of six facies and sixteen microfacies. Compositionally all the sandstone horizons are mature. Texturally four microfacies are immature and rest of the microfacies are mature to submature. The sandstone is predominantly medium grained and only four microfacies are fine grained. Quartz, carbonate and glauconite are the common cements while iron oxides and clay occur as subordinate cements. Accessory to rare amounts of tourmaline, epidote and sphene which may occur either as discrete grains or as inclusions within quartz grains suggest an ultimate derivation from sialic metamorphic-igneous basement with minor contribution from basic sources. The source granitoids were mainly S-type. However restricted suite of heavy minerals, compositional maturity and rounded to subrounded shape of tourmaline grains strongly suggest significant recycling. Diagenetic history indicates that glauconite formed from clay during early diagenesis. The formation of glauconite suggests slow rate of sedimentation and mildly reducing conditions. Suturing of quartz grains occurred during deep burial. Fracturing of quartz grains occurred during tectonic deformation in a brittle regime. Calcite cement appears to have formed during shallow burial. Silica cement in the Lumshiwal Formation owes its origin mainly to pressure solutioning and secondarily to water rising from the underlying Chichali Formation which is composed predominantly of shale. Iron oxide is believed to have formed during halmyrolysis as well as during uplift. The section of Lumshiwal Formation at Kalas is different in terms of environment of deposition compared with Lumshiwal Formation at other parts of Hazara where it shows low energy, subtidal zone. At Kalas, presence of oolites in Lumshiwal Formation indicates shallowing and shoaling of basin and high energy environment while glauconite indicates reducing subtidal environment. Lower part of the Lumshiwal Formation was deposited in reducing subtidal environment, but afterward it was followed by two periods of regression during which oolites were formed. Towards the upper part of the Lumshiwal Formation there is evidence of progressive deepening. This is shown by the absence of oolites and presence of glauconite.
Key words: Sedimentology, structure, Lumshiwal Formation.

N/3. Naeem, A., 1988. Report on Geology and Structure of Balakot-Kummi Area. M.Sc. Thesis, Punjab University, Lahore, 78p.

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 the Punjab. The report includes a detailed geological map at 1:6,000 of about 65 Km2 area along with a number of geologic 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 overthrusts 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: Geology, structure, metamorphism, Hazara-Kashmir Syntaxis, Balakot, Mansehra.

N/4. Naeem, M., 1961. Geology of Bagnotar (Abbottabad) area, Hazara. M.Sc. Thesis. Punjab University, Lahore, 28p.

Key words: Structure, Bagnotar, Abbottabad.

N/5. Naeem, M.M. & Bajwa, M.S., 1983. Geology of Kach-Tavisar area, topographic sheet No. 38 O/12, Attock, Kohat and Mianwali Districts. Geological Survey of Pakistan, Information Release 190.

Key words: Geology, stratigraphy, Attock, Kohat, Mianwali.

N/6. Naeem, M.M. & Bajwa, M.S., 1987. Geological map of Chauntra (43 C/15), Rawalpindi District, Sheet No. 16, scale 1:50,000. Geological Survey of Pakistan. Map Series.

Key words: Geology, mapping, Rawalpindi.

N/7. Naeem, M.M., Mian, M. & Bhatti, A., 1985. Geological map of Islamabad (43 G/2); Islamabad District, Sheet No. 9, scale 1:50,000. Geological Survey of Pakistan. Map Series.

Key words: Geology, mapping, Islamabad.

N/8. Nagappa, Y., 1951. The stratigraphical value of Miscellenea and Pellatispira in India, Pakistan and Burma. Proceedings, Indian Academy of Sciences, Section B, Volume 33(1), 41-48.

Key words: Paleontology, stratigraphy, miscellenea, Pellatispira, India, Pakistan Burma.

N/9. Nagappa, Y., 1957. Further occurrences of Botryococcus in Western Pakistan. American Museum of Natural History, Micropaleontology 3(1), p.83.

Records occurrences of the alga Botryococcus in Cambrian (or Precambrian) bituminous shales of Makrach and Eocene shale of Kohat, western Pakistan.
Key words: Paleontology, stratigraphy, Salt Range, Kohat.

N/10. Nagappa, Y., 1959. Foraminiferal biostratigraphy of the Cretaceous-Eocene succession in the India- Pakistan- Burma region. American Museum of Natural History, Micropaleontology 5(2), 145-177.

A synthesis of the available stratigraphic and foraminiferal evidence from the upper Cretaceous-Eocene sequence of various parts of the India-Pakistan-Burma region "shows that there were four main cycles of deposition. Each cycle is shown to have started with a transgression and ended with a regression. Evidence of minor local regression is present in some places. The earliest of these cycles ended with the Maestrichtian, and this is taken to indicate the

end of the Cretaceous period. The next cycle started with the Danian, which is now placed in the lowermost Tertiary (basal Paleocene), and continued into the Ranikot stage (Paleocene). The third and fourth cycles began with the Laki and the Khirthar stages, respectively, the two cycles together representing the whole of the Eocene."
Key words: Paleontology, stratigraphy, India, Pakistan Burma.

N/11. Nagappa, Y., 1960. The Cretaceous-Tertiary boundary in the India, Pakistan Subcontinent. 21st International Geological Congress, Copenhagen, Part 5, 41-49.

Key words: Cretaceous-Tertiary boundary, Pakistan, India.

N/12. Najman, Y., Garzanti, E., Khan, I.A., White, N. & Stix, J., 2001. Determining the rates and timing of exhumation in the Himalayan orogen: Constraints from Ar-Ar dating of detrital micas from the foreland basin sedimentary record, Pakistan. GSA-GSL Earth Sys. Proceedings Global Meeting. Edinburgh.

Key words: Geochronology, Ar-Ar dating, Siwaliks.

N/13. Najman, Y., Pringle, M., Garzanti, E., Stix, J., White, N. & Khan, I.A., 2000. Constraints on Himalayan tectonic and exhumation history determined from its foreland basins sedimentary record. Abstracts, European Union of Geologists Meeting, London, 131-132.

Key words: Tectonics, exhumation, sedimentology, foreland basin, siwaliks.

N/14. Najman, Y., Pringle, M., Garzanti, E., Stix, J., Khan, I. & White, N., 2001. The timing of movement on the Main Mantle Thrust; Constraints from the Kamlial Formation foreland basin sediment record, Pakistan. Journal of Asian Earth Sciences 19, 46.

Key words: Tectonics, Kamlial Formation, foreland basin, Siwaliks.

N/15. Naka, T., Hirayama, J. & Karim, T., 1995. Phosphorite-bearing Cambrian formations in the Himalayan fold and thrust belt, Hazara Division, northern Pakistan. Proceedings of Geoscience Colloquium, Geoscience Lab, GSP, Islamabad, 11, 148-179.

The Abbottabad area is underlain by Precambrian to Cretaceous partially metamorphosed sedimentary rocks deposited on shelves surrounding Gondwana. The Cambrian formations are thrust southeastward over the Precambrian metamorphic rocks (Hazara/Tanawal Formation) along the Panjal Thrust and are unconformably overlain by Jurassic to Cretaceous formations.
The Cambrian rocks in the study area are divided into two: the Abbottabad and Hazira Formations. The phosphorite deposits occur mainly in the uppermost part of the Abbottabad Formation and also in the Hazira Formation in a minor amount. The upper part of the Abbottabad formation, Sirban Dolomite Member, is subdivided into three units: the Lower Middle, and Upper. The Lower Unit consists of micritic dolomite and the Middle Unit of dolomite and quartzite. The Upper Unit is characterized by numerous chert intercalations in the dolomite. The economically important phosphorite deposits are recognized at least three levels in the upper part of the unit. The phosphorite deposits show generally nodular or ooid-like structure and are intercalated in dolomite. The phosphorite horizons are variable in thickness, reaching 5 m thick in maximum.
The Hazira Formation is 125 m thick and overlies the Abbottabad Formation with a minor sedimentary gap. It is subdivided into two facies: Hazira and Galdanian Facies. The Hazira facies consist of gluconite-bearing calcareous mudstone in the lower part, and sandstone in the upper part. The Galdanian Facies is composed of hematitic red mudstone, siltstone and then breccia Thin phosphorite beds occur in the lower part of the formation. Many of the thrust faults developed in the area generally parallel to the Panjal Thrust and bedding planes. The faults strike NNE-SSW, and their inclinations are moderate to steep with westward or eastward direction. Folds are divided into two

type: symmetrical open folds and asymmetrical light folds. and their half wavelengths arc about 150 m and 100 m, respectively.
Key words: Tectonics, Cambrian, phosphorite, Himalayan Fold and Thrust belt, Abbottabad.

N/16. Nakagawa, M., Yajima, J., Khan, S.R., Akram, H. & Yoshida, M., 1996. Potential applicability of the magnetic survey for prospecting of PGE in Jijal layered complex, 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, 124-127.

Key words: Geophysics, magnetic survey, Jijal Complex, Kohistan.

N/17. Nakata, T. & Tsutsumi, H., 1989. Photogrametic study on active faults of Pakistan. In: Okimura, Y. & Fatmi, M.N. (Eds.), Tectonics and sedimentation of the Indo- Eurasian colliding plate boundary region and its influence on the mineral developments in Pakistan. Hiroshima University, 69-82.

Key words: Structure, tectonics, active faults.

N/18. Nakazawa, K. & Dickins, J.M. (Eds.), 1985. The Tethys; Her Paleogeography and Paleobiogeography from Palaeozoic to Mesozoic. Tokai University Press, Japan, 312p.

The volume consists of three parts. Part I contains five papers concerning the regional aspects of the European, Himalayan, and Chinese Tethys and the general aspects of Gondwanaland and Tethys. Part II includes six papers treating the paleobiogeography and/or paleobiofacies of respective taxa, namely smaller foraminfers, fusulinids, conodonts, bryozoans, brachiopods, and land plants. Part III is a detailed report of the Permian-Lower Triassic stratigraphy, biostratigraphy, and sediments environment of the Salt Range region in Pakistan by the Pakistani-Japanese joint research group.
Key words: Palaeontology, Paleozoic, Mesozoic, Tethys.

N/19. Nanda, A.C., 2000. Some observations on the linkage, migration and extinction of the Siwalik fauna. Abstracts, Third South Asia Geological Congress, Lahore, 72-73.

The known mammalian fauna from the Ladakh Molasse Group and Murree Group indicate that during the Upper Oligocene - Lower Miocene Himalaya was never a barrier for the to- and fro- migration of the fauna. The fauna shows linkage with Europe and Central Asia and with the Bugti fauna of Pakistan. Siwalik Group (1 8.3 Ma to 0.22 Ma) overlies the Murree Group and is known for very rich occurrence of vertebrate remains. Fauna from the Lower Siwalik of Ramnagar, Jammu or even from Potwar plateau show a poor linkage with China or Central Asia , but good linkages with Europe and Africa. However, in the Middle Siwalik, fauna do not show linkage with Central Asia, and Himalaya was a barrier for the migration. Thus river valleys which might have formed convenient routes for migration in Oligo-Miocene became inaccessible to the fauna, either due to the high altitude of the Himalaya or energy in the river system was much more to permit migration of the fauna.
In the Upper Siwalik, rich mammalian collections have been made from Chandigarh and Jammu regions and sequence yielded both Tatrot and Pinjor Faunas. The collection made in the last 35 years near Chandigarh includes 3 1 marker taxa for the Pinjor Formation. In addition there are 14 taxa which although are characteristic of the Pinjor Fauna but occur in the transitional zone between the sequences which yielded Tatrot and Pinjor Fauna. The process of migration or extinction of the Pinjor Fauna ranges from 1.72 Ma to 0.6 Ma. The unfossiliferous Boulder Conglomerate Formation which overlies conformably on the Pinjor Formation is having thick sequence mainly of boulder and cobble conglomerates. The river system at that time became very furious with the abrupt rise of the Himalaya, and the energy of the rivers was enormous which forced the animal life either to migrate or to become extinct.

Thus evidence indicate that faunal migration across the Himalaya took place in Oligo-Miocene when the Himalayan rivers probably formed the favorable routes of migration. With the formation of the Siwalik Foredeep, the Himalaya started gaining rapid heights and became a barrier, and migration of the fauna along its valleys stopped. Routes of migration shifted along the southern foothills. With the extinction or migration of the Pinjor Fauna, the rivers became very furious and were having enormous energy. This inhospitable environment had caused extinction of the Siwalik fauna.
Key words: Fauna, siwaliks.

N/20. Naqvi, M.M.H., 1979-79. Mineralogy of Hini-Karam Butt Area (Hunza Valley). M.Sc. Thesis, Punjab University, Lahore, 104.

Key words: Mineralogy, Hunza.

N/21. Naqvi, S.A., Ahmed, H.M., Muneer, A. & Qayyum, A., 1983. Mineralogy, petrology and economic geology of Lahor Pazang area, Swat, Kohistan. Kashmir Journal of Geology 1, 121.

Detailed geological mapping was carried out in the Besham and allied areas on the toposheet 43 B/13 of the survey of Pakistan. The mapping has revealed the following rock units in the project area; granites, pegmatites, metamorphics of the Thakot and Salkhala groups, and a number of amphibolite dikes.
The granites and metamorphics of the area depict the varying types of conditions which affected the rocks of the area probably in Precambrian time. The granites of the area have both granular and microprophyritic textures. The two kinds have been assigned different origins.
Greater emphasis has been paid to the study of the skarn bodies. These contain significant amounts of magnetite, sphalerite, galena and molybdenite. The skarn bodies have developed by the interaction of granite with the surrounding metamorphics. Some mineralization has also resulted through a hydrothermal action. The hydrothermal mineral veins are of hydrothermal to mesothermal type. Disseminated sulphide are also occurs within the altered granite.
Key words: Mineralogy, petrology, sulphide mineralization, Lahore-Pazang, Kohistan.

N/22. Naqvi, S.A.H., 1974. Groundwater investigation in North West Frontier Province. Hydrogeology Directorate, WAPDA, North West Frontier Province, Peshawar, 12p.

Key words: Groundwater, hydrogeology, WAPDA, NWFP.

N/23. Narayana Rao, S.R., 1941. An algal flora from the Lockhart Limestone (Ranikot Series) of the Samana Range. Journal of the Mysore University, Section B– science, including medicine and engineering, 2 (2), 41-53.

Lockhart Limestone is the name given by Lt.-Col. L. M. Davies' to a compact, massive, grey limestone of some 200 feet in thickness, occurring in the region of Fort Lockhart on the Samana Range between Kohat and Thal. The Samana series as worked out by him consists of 12 beds; beds 8-12 (uppermost members of the sequence) are of Ranikot age, while the base of the series.(bed 1) extends down to the Jurassic (or even the Triassic). The Lockhart limestone (bed 10) represents the uppermost portion of the Lower Ranikot and the lower portion of the Upper Ranikot.
Key words: Stratigraphy, Lockhart limestone, Ranikot, Samana Range, Hangu.

N/24. Nasar, R.A.H. & Khan, S.A., 1983. Geology of Dara Adam Khel, Kohat, N.W.F.P., M.Sc. Thesis, University of Peshawar, 54p.

Key words: Geology, Darra Adam Khel, Kohat.

N/25. Naseem, A. & Mahmood, T., 1982. Field report on lithostructural mapping and geology of Balakot–Batrasi area, Mansehra with special emphasis on structure of the area. M.Sc. Thesis. Geology Department, Punjab University Lahore.

Key words: Mapping, structure, Balakot–Batrasi, Mansehra.

N/26. Naseem, M., 1996. Analysis of gold in Loess-paleosol deposit of Haro river area, Attock district, Punjab, Islamabad. Proceedings of geoscience colloquium, 14, 125-127.

Gold was analysed in 25 samples. Its concentration is less than 40 PPB except in two layers with 62 and 230 PPB values. The gold may be derived from the Indus placers.
Key words: Geochemistry, gold, loess-paleosol, Haro, Attock, Punjab.

N/27. Naseem, M., Iqbal, A., Kato, K. & Itoh, S., 1994. Determination of arsenic and antimony in geochemical samples using hydride formation system by Atomic Absorption spectrometry. Proceedings of geoscience colloquium, 9, 59-72.

This paper describes the hydride formation system analytical technique. It is intended to determine the optimization of a suitable procedure for the determination of As and Sb. Field survey was conducted in the Swat area for collection of geochemical samples from kaolinite deposits. The area went through a hydrothermal activity and the sampling of B horizon of the Shahdheri China clay deposit was done for the path finders As and Sb for Au. The samples form Swat showed good agreement with recommended value.
Key words: Geochemistry, Swat.

N/28. Naseem, M., Kato, K. & Aziz, A., 1996. Estimation of arsenic and antimony in clay sample using hydride formation system by atomic absorption spectrometry. Geologica 2, 157-163.

Key words: Clay, heavy metals detection, geochemistry.

N/29. Naseem, M., Khan, I.H. & Yoshida, M., 2000. Adsorption of multiple heavy metal ions on clays in Pakistan: an example of kaolinite from Salt Range and bentonite from Azad Kashmir, Pakistan. Geologica 5, 21-31.

Key words: Clay, heavy minerals, Salt range, Azad Kashmir.

N/30. Naser, R.I. & Hassan, M., 1969. Geology of the part of Hazara District between Haripur and Khanpur. M.Sc. Thesis, Peshawar University.

Key words: Clay, heavy minerals, Salt range, Azad Kashmir.

N/31. Nasir, A., Mohsin, M. & Tariq, M., 1989. Geology and beneficiation studies of Kakul phosphate, Hazara. M.Sc. Thesis, University of Peshawar, 60p.

Key words: Phosphate beneficiation, Kakul, Abbottabad.

N/32. Nasir, M., 1985-87. Electrical resistivity survey for groundwater potentials in Masal Talao, Amir Khan Talao, Khachar Talao and Haji Talao, District Peshawar. M.Sc. Thesis, Punjab University, Lahore, 90p.

Electrical resistivity survey in Masal Talao, Amir Khan Talao, Khachar Talao and Haji Talao (District Peshawar) was carried out in collaboration with Hydrogeology Directorate WAPDA Peshawar. The main purpose of the survey was to determine hydrogeological features such as depth to the bed rock, nature and thickness of aquifers, the quality of groundwater, and to select suitable sites for tubewell installation in the project area.
According to resistivity survey and drilling data the entire area is underlain by low resistive clay with occasional gravels. The overlying alluvium is composed of alternating layers of gravels and clays.
Ground water appears to be quite fresh in the entire project area. Water table depth varies from 13m to 40m in the area under investigation. In the project area, twenty seven probes were carried out. After interpreting the data, the V.E.S. No. 95, 93, 51, 40, 15 and 17 have been selected for the test drilling, however other probe sites also indicate the presence of aquifers in the area but of varying thickness. The entire area appears to be favourable for tubewell installation, however the yield of water depends upon the nature of aquifers, may range from half cusec to one and half cusec project area.
Key words: Geophysics, groundwater, resistivity, Peshawar.

N/33. Nasir, M.A., 1985-87. Geotechnical studies of land slides with special emphasis on slope stability along Karakoram Highway (From Batgram to Thakot, District Mansehra). M.Sc. Thesis, Punjab University, Lahore, 96p.

The project area is related to Hazara and Kohistan region of North West Frontier Province. Topographically the area is occupied by rugged rocks consisting of high peaks and alluvial deposits. The predominant rock types are granite, granite gneiss, schists and various other minor bodies as dykes and sills. All the structure features consider excellently to give NE trend that indicates NW-SE direction of tectonic forces.
The main objective of "Geotechnical Studies" is to analysis the scope of stability of rocks along roadside. For this purpose, various modes of failure, i.e., plane failure, wedge failure, toppling failure, rock fall, and circular failure etc., were observed. Theoretical models based on the actual readings (data) presented in the forthcoming chapters are intended to provide rational bases for the design of rock slope. It should however, be made clear that successful design of slope depends not only on the choice of correct theoretical model but also upon a number of other considerations which cannot be conveniently quantified.
A map has been provided which classifies the road segments as stable, unstable and potentially unstable. Stable segments are those which geometrically do not manifest any sign or chance of failure or show a high factor of safety i.e., 2.5 or 3. Unstable segments are those where small-scale failures are kept on taking place with every successive rainfall. Similarly potentially unstable segments are those which are stable in actual practice but ratio of their resisting forces to driving forces is less than one.
Study of various roads alignment was made to emphasize on the effects of sliding. Different modes of failure were encountered, and their factors of safety were calculated. Finally, it was decided whether dangerous road or not and an attempt have been made to give remedial measures.
Key words: Geotechnical, landslides, KKH, Batgram, Thakot, Mansehra.

N/34. Nasir, M.J., 1997. Pothole development along River Indus near Khairabad. Abstracts, 9th All Pakistan Geographic Conference, Islamabad, 6-7.

Key words: Pothole, Indus River, Khairabad.

N/35. Nasir, S. & Ahmad, I., 1988. A short note on the geology of the Bagarian Pegmatite, Mansehra district, NWFP., Pakistan. Geological Survey of Pakistan. Information Release 350.

Key words: Pegmatite, Mansehra, Hazara.

N/36. Naveed, M.A., 1982-84. Economic geology and petrology of graphite and other minerals in Naran-Paludaran area, middle northern Kaghan valley, District Mansehra. M.Sc. Thesis, Punjab University, Lahore, 120p.

Key words: Petrology, economic geology, Naran, Kaghan valley.

N/37. Nawaz, H., 1980-82. Geology of Balakot Area, District Mansehra. M.Sc. Thesis, Punjab University, Lahore, 125p.

This report incorporates results of geological mapping and investigations of about 15-miles2 area surrounding Balakot. Structurally, most significant character in an overturned anticlinal structures. The overturning is towards southwest. The overturned limb of major anticline is broken by numerous faults.
At the right side of the river Kunhar the crystalline rocks are exposed generally, while at the left side of the river, sedimentary rocks are exposed except Panjal Trap, which are meta-volcanic rocks.
Key words: Mapping, structure, Balakot, Hazara.

N/38. Nawaz, K.R., 1989. Feldspar deposits of NWFP. Geological Survey of Pakistan. Information Release 283.

Key words: Economic geology, feldspar, NWFP.

N/39. Nawaz, S., 1989-91. Geological study for petrography and geology of Fatehpur Miandum (District Swat). M.Sc. Thesis, Punjab University, Lahore, 60p.

Miandum area (Lower Swat) are part of metamorphic hornblende complex. The area lies within the Southern portion of Lower Swat. There rocks are probably the extensions of rocks of Dir in the form of a belt running approximately in East-West direction. The area given field work comprises 30 miles in the North- West of Saido-Sharing. The area mainly comprises the main rock units are amphibolite, Norite, Diorite, quartz-o-feldspar and pegmatite veins amphibolites have been metamorphosed basic rocks probably Norite gabbro. As the field evidences, and the Laboratory study shows that the amphibolites were formed from basic magma, which has undergone regional metamorphism under the intense orogenic conditions. Quartz-o-felspathic and pegmatite veins are extensively distributed all over the area, indicating the evidence of diorite magma. Major minerals are plagioclase, Hornblende, epidote and quartz with accessories as sphene and magnetite. These are products of regionally metamorphosed igneous rocks.
Key words: Petrology, petrography, Fatehpur, Swat.

N/40. Naz, M.A., Naqvi, A.A. & Safdar, M., 1964. Evaluation of some West Pakistan clays. Pakistan Journal of Scientific and Industrial Research 7, 174-181.

Twenty-seven clay samples from different regions of West Pakistan have been studied. The tests include chemical analysis, infrared absorption analysis, plasticity, water of plasticity, drying and firing behavior including shrinkage, water absorption and colour. The majority of these clays have been found suitable for different uses in the ceramic industry.
Key words: Clay deposits, West Pakistan.

N/41. Nazir, R., Hussain, M. & Rehman, H., 1995. Evaluation of Eocene shale associated with Jatta gypsum as a potential hydrocarbon source in Shakardara area, Kohat, N.W.F.P. M.Sc. Thesis, University of Peshawar, 57p.

Key words: Hydrocarbons, shale, gypsum, Eocene, Shakardara, Kohat.

N/42. Nazirullah, R., Alam, K. & Hussain, M., 1988. Geologic investigation for graphite prospects in Ghore Maidan, Mohriwali area, Neelum valley, Azad Jammu and Kashmir. Geological Survey of Pakistan, Information Release 337.

Key words: Geology, structure, graphite, Neelum valley, Azad Kashmir.

N/43. Negrotto Cambiaso, F., 1911. Rilievo fotogrammetricao alla scala di 1: 100,000 nella regione del Karakorum (Imalia Occidentale) comprendente gran parte della estrimeta superiore del Ghiacciao Baltoro ed I Ghiacciai Godwin Austin e Savoia. In: De Filippi, La spezione nel Karakoram. Relazioni Scientifiche, 1-19. Zanichelli, Balogna.

This is a photogrammetric study of the Godwin Austin and Baltoro glaciers area at a scale of 1: 100,000.
Key words: Photogrammetry, Baltoro, K2, Karakoram.

N/44. Neve, A., 1907. Rapid glacial advance in the Hindu Kush. Alpine Journal, 23, London.

Key Words: Glaciation, Hindukush.

N/45. Ni, J.F., Ibenbrahim, A. & Roecker, S.W., 1991. Three-dimensional velocity structure and hypocenters of earthquakes beneath the Hazara Arc, Pakistan: Geometry of the underthrusting Indian Plate. Journal of Geophysical Research 96, 19865-19877.

The three-dimensional P and S wave velocity structures and hypocenters of 420 events beneath the western Hazara Arc are obtained simultaneously by inverting travel time data observed at fifteen Tarbela seismic stations. In general, the P and S wave velocity distribution of the top layer (0–6 km depth) correlates well with surface geology. Within this layer we find a low-velocity region beneath the Hazara Thrust Zone (HTZ) corresponding to the underthrusted Murree Formation, and there are high-velocity regions south of the Main Mantle Thrust (MMT) which are associated with the exposed Cambrian, late Paleozoic, and Tertiary granites. A low-velocity zone immediately to the west of the Hazara-Kashmir Syntaxis (HKS) indicates the existence of a Miocene foreland basin which is covered by late stage southeasterly directed thrusts along the Hazara Arc and is consistent with the idea that the HKS is detached from the lower crust. From the Salt Range to the HTZ, the Indian plate dips at a shallow angle, about 2°–3° to the northeast. North of the HTZ the underthrusting Indian plate dips gently to the northeast with an increased slope of 5° to 8° until it reaches the Indus-Kohistan Seismic Zone (IKSZ). Along the NW trending IKSZ the Indian plate bends more steeply to the northeast beneath a seismically active mid crustal wedge directed to the southwest. The larger events in the IKSZ are interpreted as occurring on a major thrust zone that can be followed to a depth of 24 km. The IKSZ appears to consist of an upper seismic zone (from the surface to about 8 km) and a lower seismic zone (12 km to 24 km) separated by an aseismic region about 4 km thick. The lower IKSZ may represent the leading edge of a southwestward directed slab which has not yet ruptured the surface. Hypocenters of relocated earthquakes indicate that the HTZ is about 30 km wide with most of the larger microearthquakes occurring at 12–14 km. Seismicity along the HTZ suggests that the Panjal, and Murree thrusts are active.
Key Words: Seismology, earthquakes, structure, Indian Plate, Hazara Arc.

N/46. Nicora, A., Angiolini, L. & Gaetani, M., 1992. The Permian/Triassic boundary in Hunza valley (N. Karakoram). Abstract Volume, 7th Himalaya-Karakoram Workshop, Department of Earth Sciences, Oxford University, England, 61.

The Permo-Triassic sedimentary succession of the north Karakoram microplate is a typical succession of a passive continental margin and records the opening of Neotethys. The continental margin starts to be built up during Sakmarian-Artinskian with the deposition of a deltaic to subtidal terrigenous succession (Gircha Formation) and of a

thick carbonate platform (Panjshah Formation). During Murgabian the extensional tectonic related to the rifting of Neotethys results in the downwarping of the platform and in the deposition of pelagic limestones with white chert (Kundil Fm.), Late Permian in age.
In 1991 the Italian expedition to the Chapursan Valley (upper Hunza Valley) discovered new pelagic many formation overlying the Upper Permian cherty limestones and passing upward to the anoxic limestone with black chert of the Borom Formation (Early to Middle Triassic in age). This new stratigraphic unit has been named Wirokhun Formation (Wirokhun Pass,) 4300 metres a.s.l., on the right idiographic side of the Kundil Valley) and corresponds to the unnamed unit in Gaetani et al., 1990. Its lithology chiefly consists of thin bedded marly limestones alternating with black shales and marls. The Wirokhun Formation contains the Permo/Triassic boundary in its uppermost portion based on conodont associations. At present the basal Dorashamian and the Early Dienerian have been detected.
Key words: Sedimentation, Permo/Triassic boundary, Karakoram Hunza valley.

N/47. Nida, Y., Terai, Y., Khan, S.R. & Kausar, A.B., 1998. Origin of chromitites from the Jijal complex, Kohistan arc, North Pakistan. Geological Bulletin, University of Peshawar 31 (Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop), 140-141.

The Jijal complex is a tectonic wedge of layered ultramafic cumulates and garnet granulites exposed at the base of the Cretaceous Kohistan arc [1-2]. The lower half of the complex is composed of layered peridotitic and pyroxenitic rocks, which are strongly mylonitized and amphibolitized, especially along the Main Mantle Thrust. Towards the central part of the complex the rocks are fresh and the primary minerals, magmatic textures and structures are well preserved.
On the basis of chemical composition of constituent minerals, the ultramafic rocks are classified into two series. The orthopyroxene-free dunite-chromitite series is composed of dunite, wehrlite and chromitite having high-Mg#, high-Cr# and low-Ti. The second series is pyroxenite series, comprising dominantly of clinopyroxenite, websterite and small amounts of dunite, wehrlite, chromitite, with relatively low-Mg#, low-Cr# and high-Ti. Rocks of both the series occur irregularly and are mixed, suggesting magmatic interaction of crystal mushes during the process of crystallization. At places a number of clinopyroxenite dykes and veins cross-cut the dunite-chromitite series rocks.
The chromitite occurs as disseminated and massive bodies in close association with dunite and clinopyroxenite of both the series. Clinopyroxene-chromitites are rarely observed in the pyroxenite series. The mode of occurrence of the Jijal chromitites is similar to the stratiform-type chromitites and sometimes similar to podiform-type chromitites in ophiolitic sequences. Rhythmic layering, modal gradation of chromite and cross-bedded structure in disseminated chromitites, suggest gravitational control during the deposition of chromitite.
Olivine ranges from Fo(95.4-90.8) in chromitites to Fo(91.5-89.4) in dunites for the dunite-chromitite series, and from Fo(93.0-87.4) in dunite, Fo(90.6-89.2) in wehrlite, Fo(89.286.1) in clinopyroxenite, to Fo(84.1-80.6) in websterite for the pyroxenite series. The variation in NiO wt.% of olivine with decreasing Fo content in the dunite-chromitite series shows a fractionation trend clearly distinctive from that in the pyroxenite series. The systematic Mg# change of spinel and clinopyroxene cores with the lithological change from chromitite through dunite to pyroxenite also suggests a fractional crystallization in separate magmatic processes. The range of Cr# of spinel cores from the dunite-chromitite series (Cr#=86.1-66.3) is higher than that of the pyroxenite series spinel cores (Cr# = 73.5-42.6). The Cr# and Mg# variations also display separate fractionation trends from chromitite, through dunite and wehrlite, to pyroxenites. The TiO2 contents in spinel cores are 0.62-0,10 wt.% for the dunite-chromitite series, and 2.08-0.20 wt.% for the pyroxenite series. Clinopyroxene mineralogy also supports the above explanation.
The chemistry of the constituent minerals suggests that the magmas for the formation of Jijal ultramafic cumulates can be explained as boninitic for the dunite-chromitite series and island-arc basaltic for the pyroxenite series. The very high Cr# range of the dunite-chromitite series spinels is consistent with that of spinels in boninites [21, whereas the pyroxenite series spinels also have high Cr# range which is consistent with that of island-arc basalt magma derived from highly depleted mantle peridotites [31. Extremely high Fo content in the dunite-chromitite series olivines and a moderately high Fo content in the pyroxenite series are suitable to the parentage described above. The extremely low content of TiO2 in spinels (< 0.5 wt.%) and in clinopyroxenes (< 0.03 wt.%) from the dunite-chromitite series rocks characterizes the magma type as boninitic one. It can be assumed that an interaction process between two different magma types "boninitic and island-arc basalt" has taken place within a single, large-scale magma chamber.
Key words: Tectonics, ultramafics, chromitites, Jijal, Kohistan.

N/48. Niida, K., Kausar, A.B. & Khan, S.R., 1996. Ultramafic crystal mush intrusion into crystallization magma chamber: Field evidence from the Chilas complex, northern Pakistan. 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, 157-171.

Modes of occurrence of the dunite-wehrlite intrusions and the field relationships between the intrusion and the gabbroic host rocks were reported from the Chilas complex of the Kohistan island arc, northern Pakistan.
A model of ultramafic crystal mush intrusion into crystallizing gabbroic magmas was discussed to examine the heterogeneous lithology of ultramafic-mafic associations in the main gabbronorites of the complex The well-developed layering of gabbroic to anorthositic rocks, dyking of wehrlite in gabbroic hosts, incorporation of wehrlitic xenoblocks and senocrysts into gabbros, and other heterogeneous lithology are closely associated with the dunite-wehrlite intrusions. This suggests that the ultramafic crystal mush intrusions genrerated during crystallization of the gabbronoritic host magmas.
Key words: Ultramafic crystal mush, crystallization, magma chamber, Chilas complex, Kohistan.

N/49. Ninglian, W., Tandong, Y., Zongtang, F. & Zhiqiang, 2000. Chemical weathering in the Batura glacier basin, Karakoram Mountains. Abstract Volume, 15th Himalaya-Karakoram-Tibet Workshop, (Chengdu) China, 440.

Glacially driven chemical weathering could make concentration of CO_2 in the atmosphere decrease, and the process might play a significant role in climate change and the carbon cycle. So the study of chemical components and their contents of glacial meltwater in an alpine glacier-covered catchment has important geochemical and climatological significance.
Batura Glacier is large glacier located in the Karakoram Mountains. Its length is about 59.2 km. The glacier basin is 687 km^2, in which 332 km2, nearly a half of the basin, is occupied by glacier. The lowest limit of the glacier is 2540 m.a.s.1., where mean annual temperature is about 10ºC, and annual precipitation is about 97 mm. According to the hydrological measurement in 1974-2975, the runoff of Batura River was about 9.3X108m3 at the terminus of the glacier.
In 1994, the Batura Glacier was investigated again for its variations. Meanwhile, the discharge of the Batura River was measured, and ice and meltwater samples were collected during that field season. In this paper, we report the analytical results of major ions in the ice and meltwater of the Glacier. And based on these data, it is found that chemical weathering in the catchment of this glacier is intense (Table 1), and the cation denudation rate, reaching the level of the tropical very humid regions, is much larger than that in the arid regions.
Key words: Weathering, glaciers, Batura, Karakoram.

N/50. Nio, S.D. & Hussain, S.T., 1981. Sedimentary study of Neogene Quaternary fluvial deposits in the Bhittani Range, Pakistan. Proceedings, Neogene-Quaternary Boundary Field Conference, India, 1979, 177-183.

Key Words: Sedimentary petrology, fluvial deposits, Neogene-Quaternary boundary, Bhittani Range.

N/51. Nio, S.D. & Hussain, S.T., 1984. Sedimentological framework of Late Pliocene and Pleistocene alluvial deposits in the Bhittani Range, Pakistan. Geolgie in Mijnbouw 16, 55-70.

Key Words: Sedimentology, Pliocene-Pleistocene, alluvial deposits, Bhittani Range.

N/52. Nisar, A.K. & Kella, S.C., 1968. Iron-manganese deposits of Churgali (Hazara). Report West Pakistan Industrial Development Corporation, 20p.

Key words: Mineral deposits, iron, manganese, Churgali, Hazara.

N/53. Nizam-din, 1998. Paleoclimatic reconstruction of the Late Pleistocene loess-paleosol deposits in the Attock Basin, North Western Himalayan Foothills, Pakistan. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop, 50-51.

Late Pleistocene (approx. 18-130ka) loess-paleosol deposits exposed along the Haro river, Attock basin Pakistan, north western Himalayan Foothills has been studied for stratigraphy, particle-size distribution, geochemistry and paleoclimatic investigation. The deposits cover approximately 30-km2 area and are up to 20 meters in thickness. The deposits are mostly composed of less-weathered loess while at least seven highly-weathered paleosol beds, PS-1-7 in descending order, are intercalated. Loess beds are generally light brown to brown in color, poorly-stratified, porous, and calcareous. Paleosols are generally dark reddish brown in color and have vertical partings and solution cavities

Particle-size distribution analysis of the loess-paleosol deposits shows that loess beds have generally unimodel, well-sorted, leptokrutic, and negatively-skewed particle-size population whereas the paleosols have bimodel and poorly-sorted population. Loess deposits are generally composed of high percentage of silt-size particles while paleosols are rich in sand-size particles. On the basis of median particle-size (Md in ϕ scale), silt content (in weight %), and modal analysis, the loess-paleosol sequence can be divided into two part: The lower part, below the PS-4 paleosol bed show relatively coarser population with smaller Md ϕ values and larger sand-content (wt%) attribute to an increase of local input of coarser materials and/or aggregating fine particles caused by relatively active pedogenesis during the accumulation of loess deposits. On the other hand the upper part, above the PS-4, gives relatively finer population with larger Md ϕ values and larger silt-content (wt%) representing lower pedogenic activity during the deposition. (Nizam-Din & Yoshida, 1997)

Geochemical analysis of the loess paleosol deposits shows that the loess has high weight percent Of SiO2 and CaO with respect to the paleosol enriched in A1203 and Fe203. Stratigraphic variation of chemical composition and molecular weathering ratios (Retallack, 1990) in the loess-paleosol sequence also reveals a two fold division. The lower part shows high concentration of AI, Fe & Mn and a dominant effect of hydrolysis, hydration and Ca dissolution representing a humid and warm climate. Conversely the upper part shows relatively high concentration of Na, Ca, & LOI and is more oxidized, salinized, dehydrated which is probably caused by and cool climatic condition during the accumulation of upper part.

Similarly the magnetic susceptibility of the loess-paleosol deposits (Akram & Yoshida, 1997) also show a systematic variation. In the upper part show low values marking and climate and very high values in the lower part representing a comparatively warmer conditions.

These drastic change in particle-size distribution, geochemical characteristic and magnetic susceptibility between the upper and lower parts of the loess-paleosol sequence possibly provides a terrestrial record of continental paleoclimate in the area during late Pleistocene: i.e. it can be interpreted in terms of relative strength of paleo-monsoon winds by the model in Chinese loess plateau (Heller et al, 1991). That is, the lower part is marked by intense summer monsoon winds whereas the upper part is dominated by stronger winter monsoon winds. This climatic deterioration in the section may correspond to the climatic change from the Last Interglacial to the Last Glacial epoch of Himalayan glaciation.

Key words: Pleistocene, loess deposits, Attock Basin, Himalaya.

N/54. Nizam-din, Ahmad, M.N., Akram, H. & Yoshida, M., 1996. Particle size distribution analysis of Late Quaternary Loess-paleosol deposits in Haro river area, Attock district, Punjab. Geoscience colloquium 14, 77-97.

Key words: Quaternary, loess deposits, Attock, Punjab.

N/55. Nizam-din, Yoshida, M., Akram, H. & Ahmad, M.N., 1996. Particle size distribution analysis by sieving and centrifugal analyser: An example from Quaternary loess-paleosol deposits. Geologica 2, 143-155.

An eleven meter thick section of the Quaternary loess deposit exposed along the Haro river was measured. The loess section comprises of twenty- less-weathered loess beds and four highly weathered beds called "paleosols" showing a change in climate and depositional environment of these deposits. Grain size distribution of the loess deposits shows that loess beds have generally unimodel, well-sorted leptocratic and fine skewed population whereas paleosols are bimodel and poorly-sorted Loess deposits have high percentage of silt size particles while paleosols are rich in sand size particles.
Key words: Quaternary, loess deposits, sedimentology.

N/56. Nizami, A.R. & Rehman, F., 1992. Importance of nepheline syenite rocks of Koga, Distt. Swat, NWFP, Pakistan. Mountnews 5, 78-82.

Large deposits of nepheline syenite occur in or near Koga in Buner. This note describes the potential industrial use of the deposit on commercial scale, especially in ceramic industry.
Key words: Economic geology, nepheline syenite, Koga, Buner.

N/57. Nizami, A.R., Rehman, F. & Khan, I.H., 1992. A Note on the use of nepheline syenite from NWFP Pakistan. Acta Mineralogica Pakistanica 6, 161-163.

Large deposits of nepheline syenite occur in or near Koga in Buner. This note describes the potential industrial use of the deposit on commercial scale, especially in ceramic industry.
Key words: Economic geology, nepheline syenite, Koga, Buner.

N/58. Nizami, M.S. & Farooq, M.K., 1990. Geology and evaluation of recently exposed lower Jurassic glass sand deposits of Datta Formation in the Salt Range and Surghar Range, Pakistan. Geological Bulletin, Punjab University 25, 62-69.

A number of comparatively new glass sand deposits in the Salt Range and Surghar Range were studied geologically to know the nature of country rocks and feasibility of mining. Five representative specimens from the same deposits were analysed physio-chemically and evaluated regarding glass manufacture. Two of these were found suitable for producing general colorless such as container glass and sheet glass and third one for coloured glasses. The remaining two might find utilization in ceramic industry, as one was more fine-grained while the other contained less SiO_2 than required for glass melting.
Key words: Economic geology, silica sand, Datta Formation, Salt Range, Surghar Range.

N/59. Nizamuddin, M., 1992. Structural traps in the Potwar basin, Pakistan. Abstracts, First South Asia Geological Congress, Islamabad, 30-31.

Key words: Hydrocarbons, structural traps, Potwar.

N/60. Noetling, F., 1897. Fauna of Baluchistan and N-W Frontier of India. The fauna of the Neocomian belemnite beds. Geological Survey of India, Memoirs, Palaeontologica Indica, Series 16, 1(2), 5p, 2pls.

First paragraph of the book: The oldest formation seen in the sections of the Mari hills of Baluchistan is represented, according to Messrs. Griesbach and Oldham, by a massive limestone which is generally devoid of fossils, or at most contains some ill-preserved fossils here and there; commonest are Brachiopods belonging to the genera Rhynchonella and Terehratvila. It is clear that these two genera would not have been sufficient to determine the age of the " massive limestone " with certainty, but fortunately Lala Kishen Sing of the Geological Survey

discovered a rich fauna of ammonites in these deposits near Mazar Drik. It is, however, to be regretted that almost every specimen has suffered more or less from deformation by pressure, and that the finer structure of the sutural line has been completely destroyed in every case. Under these circumstances the specific determination would have been exceedingly difficult had I not been able to compare this collection with the type specimens from the Jurassic beds of Kutch, which have been so diligently worked out by Professor Waagen. The only fault which I have to find with this fine publication consists in the fact, that the figures of the specimens described do not always represent the original in its actual state, but that they are in many cases considerably, and not always happily, restored. The determination from the figures only, as given in Professor Waagen's publication, is therefore extremely difficult, and it may be noticed that my figures differ considerably from those of the species of the same name as shown by Professor Waagen. I have, however, convicted myself by actual comparison with the Kutch originals that the specimens here described under specific determinations attributed by Professor Waagen to forms from Kutch, are really identical with these species, notwithstanding the apparent difference of the figures. In two cases, however, I felt under an obligation to reproduce two of Professor Waagen's originals, in order to prove to the reader the identity of the Baluchistan forms with those from Kutch, as the published figure of the Kutch species differs considerably from the type specimen. The Jurassic limestone of Mazar Drik has up to the present yielded 22 species, of which 17 have been determined specifically, while of 5 only the genus could be determined. Out of the 17 species specifically determined, 16 could be identified with species already described, while one form, Perisphinctes baluchistanensis, could be recognized as new. The 22 species mentioned represent the following classes Braehiopoia 2 species (two especially deteruiined), Pelecfffioda, 3, Gastropoda 1 (none), Cephalopoda 16, (15).
Key words: Paleontology, fauna, belemnite beds, Baluchistan, NWFP.

N/61. Noor, I., 1978. Geology and structure of the part of the area, north of Babri Banda, Kohat District, North West Frontier province, Pakistan. M.Sc. Thesis, University of Peshawar, 78p.

Key words: Geology, structure, Kohat.

N/62. Norin, E., 1925. Preliminary notes on the late Quaternary glaciation of the northwestern Himalaya. Geog. Annaler 7, 165-194.

Key words: Glaciation, Himalaya.

N/63. Norine, E., 1946. Reports from Scientific Expedition from NW province of China under leadership of Swen Hedin. Publication 29, III geology 7, geological expeditions in western Tibet, Stockholm.

This is a report of the geological studies in, perhaps, eastern Karakoram and the bordering regions. The granitic rocks are considered to be of three principal types; a. biotite granite, post Paleozoic and perhaps post Triassic, but pre Sinonian, b. plagioclase granite, referable to the late Cretaceous or lower Tertiary, C. biotite-hornblend granite of Tertiary age.
Key words: Granites, Karakoram.

N/64. Norine, E., 1976. The "Black Slates" formations in the Pamir, Karakorum and western Tibet. In: International Colloquium on the Geotectonics of the Kashmir Himalaya–Karakorum–HinduKush–Pamir Orogenic Belt. Rome, 1974, Atti dei Convegni Lincei, 21, 245–264.

Key words: Slate, Pamir, Karakoram, Tibet.

N/65. Nosenko, G.A., 1993. Distribution and regime of Karakorum glaciers from space imagery. Mapping Sciences and Remote Sensing 13, 85-95.

Key words: Remote sensing, glaciation, Himalaya.

N/66. Novarese, V., 1911a. Appunti geologiche intorno alla Spedizione di S.A.R. il Duca degli Abruzzi nel Karakoram. In: De Filippi, La spezione nel Karakoram. Relazioni Scientifiche, 65-85, Zanichelli, Balogna.

Key words: Geology, Italian Expedition, Karakoram.

N/67. Novarese, V., 1911b. I resultati scientifici della Spedizine di S.A.R. il Principe Luigi Amedeo di Savoia nel Karakoram. Bollitin Soc. Geogr. Ital., ser.V, I, 355-365.

Key words: Italian Expedition, Karakoram.

N/68. Nowroozi, A., 1972. Focal mechanism of earthquakes in Persia, Turkey, West Pakistan and Afghanistan and plate tectonics of the Middle East. Bulletin of the Seismological Society of America 62, 823-850.

Focal mechanism solutions are determined for 23 earthquakes that occurred from 1965 to 1970 in Persia, Turkey, Pakistan, and Afghanistan. These mechanisms were obtained from the long-period first-motion P waves recorded by the World-Wide Standardized Seismograph Network stations. Mechanism solutions for the earthquakes in the folded foothills of the Zagros are predominantly thrust faulting, but depending on the assumed crustal velocity, many have strike-slip components. Cross sections of the seismic zone of the folded foothills of the Zagros show that the earthquakes are confined to a possible lithospheric slab nearly 60 km thick dipping 10° to 20° toward the north. For the earthquakes with focal depth of about 200 km, in the Hindu Kush in Afghanistan, mechanism solutions are characterized by a nearly horizontal compressional axis and a steeper extensional axis. The seismic zone appears as a contorted slab-like structure 20 to 30 km in width. This lithospheric slab may be a remnant of the Tethys Sea floor. Consistent right-lateral strike-slip mechanism solutions are found for earthquakes on the Anatolian fault in Turkey. For earthquakes on the Ferdows fault in eastern Persia, mechanism solutions vary from pure left-lateral strike-slip faulting to pure thrust faulting. Mechanism solutions for earthquakes on the Kirthar-Sulaiman shear zone in West Pakistan show consistent left-lateral strike-slip motion on a fault plane that strikes north-south. This is in agreement with the northward movement of India with respect to Afghanistan. On the basis of seismic and geological evidence, the entire Middle East is divided into eight plates which are moving northward, at different rates, with respect to Eurasia. The differential motion between various plates can explain the sense of offset and other geological features.
Key words: Tectonics, seismology, earthquakes, Persia, Turkey, Pakistan, Afghanistan.