D/1. Dainelli, G., 1909. Italiani nel Caracorum. Nuova Antologia 265, 101-109 (Roma).

Key words: Karakoram, expedition.

D/2. Dainelli, G., 1914a. Intorno alla morfologia Himalayana. Appunti Critici ed osservazioni preliminary. Rivista Geografica Italiana 21, p.189 and 355.

Key words: Geomorphology, Himalaya.

D/3. Dainelli, G., 1914b. Italian Expedition to the Himalaya and Karakoram. 13 vols. Zanichelli, Bologna.

Key words: Italian Expedition, Karakoram, Himalaya.

D/4. Dainelli, G., 1917. Ghiacciai artificiali. Bollettino della Sezione Fiorentina dell Club Alpino Itliano 8.

Key words: Glaciers, Karakoram, Himalaya.

D/5. Dainelli, G., 1921. Sul glaciale del Caracorum e dell'Himalaia dell Cashmir. Atti 8th Congresso Geografi, Italy, 2, 12-19.

Key words: Glaciers, Kashmir, Karakoram, Himalayas.

D/6. Dainelli, G., 1922a. Studi sul glaciale. Spedizione Italiana de Filippi nell'Himalaia, Caracorum e Turchestan Cinese (1913-1914), Series II, 3, Zanichelli, Bologna, 658p.

Key words: Glaciers, Karakoram, Himalayas, Chinese Turkistan.

D/7. Dainelli, G., 1922b. A proposito della trascrizione dei nomai geografici della regione dell Caracorum. Rivista Geografica Italiana 29, 162-167.

Key words: Geography, Karakoram.

D/8. Dainelli, G., 1922c. La vita dei un'oasi Balti (alta valle dell'Indo). La Terra e la Vita.

Key words: Balti, Indus.

D/9. Dainelli, G., 1922d. Study sul glaciale. Italian Expedition, De Philippi nell'Himalaya, Caracorum e Turchestan Cinese (1913-1914), Ser II, vol. 3, Bologna.

Dainelli made contribution on the glaciers of the region during the expedition. Although he did not have the opportunity of visiting the erratics of Punjab, he also addressed their problem. He summarized the views of Theobald (1874, 1877, 1880) and Wynne (1877, 1878, 1881) and explained their occurrence according to his opinion. He thought that the blocks were deposited on the bottom of a lake extending over the area where the blocks were found. The glacier snout of the Indus faced this lake. This event is thought to have taken place during the second of the four glacial expansions he considers likely to have occurred, as the lake formed between the first and the second of his suggested glacial expansions due to the marginal lifting of the Himalayan range.
Key words: Italian Expedition to Karakoram (1913-14), glaciers, Punjab erratics

D/10. Dainelli, G., 1922–34. Relazioni Scientifiche della Spedizione Italiana De Fillipi nell'Himalaia, Caracorum e. Turchestan Chinese (1913–14). Series II, volume I Storia dee'esplorazione (1934), volume II: La serie dei terreni (1934), volume III: Studi sul Glaciale (1922), volume IV La condizioni fisiche attauli (1928), volume VIII La condizioni delle genti (1924). Zanichelli, Bologna.

Key words: Scientific results, Italian Expedition to Himalaya, Karakoram and Chinese Turkestan.

D/11. Dainelli, G., 1927/1931. Viaggio ai grandi ghiacciai del Caracorum orientale. Annuario dell Club Alpino Accademico Italiano 1927/1931, 21p.
Key words: Glaciers, Karakoram.

D/12. Dainelli, G., 1923. I ghiacciai del Caracorum. La Tera e la Vita 2.

Key words: Glaciers, Karakoram.

D/13. Dainelli, G., 1928a. Catalogo dei ghiacciai dell Caracorum. Relazioni Scientifiche della Spedizione Italiana de Flippi nell'Himalaia, Caracorum e Turchestan Cinese (1913-1914), Series 2(4). Zanichelli, Bologna.

Key words: Expedition, Himalaya, Karakoram, Turkestan.

D/14. Dainelli, G., 1931. Il maggiore ghiacciaio della terra. Il ghiacciaio Siacen nel Caracorum. Vie d'Italia e del Mondo 37, 801-809.

This is a description of the Siachen Glacier. It is considered as the major glacier on earth.
Key words: Glaciers, Siachin, Karakoram.

D/15. Dainelli, G., 1932. A journey to the glaciers of the eastern Karakoram. Geographical Journal 79, 257-274.

This paper was read at the Evening Meeting of the Society on 11 January 1932. Following is the first page of the paper.
It may perhaps seem superfluous that I should say why I undertook this journey into Eastern Karakoram. But for its story's sake I may mention that I had the great fortune of being a member, as Geographer and Naturalist, of the memorable expedition organized by Dr. Filippo De Filippi and led by himself in 1913-14. During that time I asked and obtained from the leader the widest freedom of action and movement. And thus for a whole year and a half, nearly always alone with my very light personal caravan, I was in continual movement, because I knew it was necessary, for my own experience of the region and for the contribution I could bring to its knowledge, that I should see as many valleys and glaciers, as many plateaux and villages or shepherds' camping grounds as I possibly could. And thus at the end of the expedition I could say to myself I knew all Baltistan and all Ladakh and the first Tibetan plateaux as far as Pankong lake and the Aksai Chin. One blank, however, had remained: the Nubra valley from its mouth in the Shyok valley to its origin in the Siachen glacier. The Nubra valley in its lower half is frequented by caravans which cross the Karakoram Pass during the summer, and it has been followed by various travellers; however not much was known about it, and I had special ideas regarding its population, from an anthropological point of view. The upper half of the valley had been climbed by very few travellers indeed, of the old ones Moorecraft in 1821, Vigne in 1835, Thomson and Henry Strachey in 1848, and some years later by Drew. Then we come to quite modern times, with Longstaff in 1909 and the Vissers in 1929; but its geological conditions were practically unknown. At the head of the Nubra valley is the Siachen glacier, which is said to be the largest glacier on Earth outside Polar regions. Longstaff had discovered and been on it in 1909, the Workmans followed in 1911 and 1912, and also the Vissers climbed it in 1929, but only for a few miles from the front upwards. Of the geological

conditions of its immense basin nothing was known. And this represented the chief blank in my personal knowledge and in connection with the attempt that I have been preparing for years, of reconstructing the geological history of the entire region, which is the last part, and perhaps not the least important, of the scientific results of the De Filippi Expedition.
Key words: Glaciers, Karakoram.

D/16. Dainelli, G., 1933a. Resulti geologici e geografici: La serie dei terreni. Spedizione Italiana De Fillipi nell'Himalaya, Caracorum a Turchestan cinese (1913-14). Series 2, Volume 2, Zanichelli, Bologna, 458p.

Key words: Geology, Geography, Himalaya.

D/17. Dainelli, G., 1933b. La mia spedizione al ghiacciaio Siacen nel Caracorum orientale. Bollettino Comitato Glaciologico Italiano 13, 39-57.

Key words: Glaciers, Siachin, Karakoram.

D/18. Dainelli, G., 1933c. Exploratori italiani nell'Himalaya. Le vie d"Italia e del modo, 1, 437-457.

Key words: Italian exploration, Himalaya.

D/19. Dainelli, G., 1934a. La esplorazione della region e fra l' Himalaia occidentale e il Caracorum e Turchestan Cinese (1913-14), 2(1), 430p.

Key words: Geology, geography, Himalaya, Karakoram, Chinese Turkestan.

D/20. Dainelli, G., 1934b. Relazioni scientifiche della Spedizione Italiana de Filippi nell' Himalaia, Caracorum e Turchestan Cinese. Series 2A, Risutati Geologici e geografici. II, L Serie dei Terreni. Zanichelli, Bologna.

Key words: Geology, geography, Himalaya, Karakoram, Chinese Turkestan.

D/21. Dainelli, G., 1934c. Relazioni scientifiche della Spedizione Italiana De Fillipi nell'Himalaia, Caracorum e. Tuchestan Chinese (1913–14), Series Iia, La Serie dei Terreni: Vol. II, Bologna: Zanichelli, 230p.

Key words: Geology, geography, Himalaya, Karakoram, Chinese Turkestan.

D/22. Dainelli, G., 1939. Beitrage zur geologie des Himalaya. Geolgische Gesellschaft (Wien), Mitteilungen, Band 30-3, 1-36.

Key words: Geology, Himalaya.

D/23. Dainelli, G. & Marinelli, O., 1915. Cenni speciali intorno alle ricerche di geologia ae geografia. Relazione preliminare sui lovari scientifici della sepdizione de Filippi al Caracorum (1913-14). Rivista Geografica Italiana 22, p.236.

Key words: Geology, geography, Himalaya, Karakoram.

D/24. Dainelli, G. & Marinelli, O., 1917. Osservazioni sui ghiacciai subarranti l'alta valle dello Shaiok (Caracorum). Rivisti Geografica Italiana 24, 81-223 & 307.

Key words: Glaciers, Shyoke, Karakoram

D/25. Daniel, C., 1972-73. Detailed gravity survey of Gilgit Valley, northern areas of Pakistan. M.Sc. Thesis, Punjab University, Lahore, 142p.

A detailed gravity survey comprising of 256 observation covering an area of 15 miles2 was conducted for delineation of subsurface geology. The spacing of stations along profiles was kept 1 furlong. Total number of profiles spread was 18 and was spaced 3 furlong apart from each other. The scale was 1:15840. The contour interval kept for Bouguer anomaly map was 0.5 mgals.
In order to get gravity values of all the stations the Master Worden Gravimeter Model 111 No. 955 with scale constant 0.0902/S.D.* was used to conduct geodetic survey, a Russian Transit Theodolite T.T.S. was used. The main gate Marcopolo Inn (Gilgit) was selected the base station, and all the profiles were connected to the base station. Since the regional gravity anomaly map should have regional effects, therefore Bouguer anomaly map was not taken into account. The residual anomaly was considered to be the most suitable. The anomalies developed in residual anomaly map were described very carefully.
Residual anomaly map was prepared after Griffin's and second derivative map was prepared after Elkin's. The various graphical curves obtained from anomalies along different cross-sections were compared with standard curves given in 'The Theory Applied Geophysics by Grant and West'.
Key words: Gravity survey, geology, Gilgit.

D/26. Danilchik, W., 1961. The iron formation of the Surghar and western Salt Range, Mianwali District, West Pakistan. USGS, Professional Paper 424-D: 222-231.

Key words: Iron ore, Surghar, Slat Range, Mianwali.

D/27. Danilchik, W. & Shah, S.M.I., 1967. Stratigraphy and coal resources of the Makarwal Area, Trans-Indus mountains Mianwali district, Pakistan. USGS, Professional Paper 131, 38p.

The Makarwal area of the Trans-Indus Salt Range (Surghar Range) presents an excellent section of thick, fossiliferous sedimentary rocks. The lower part comprises Upper Jurassic (barosh) Limestone, followed upward by Lower Cretaceous sandstone Belemnite-bearing rocks, sandstones (Lamshiwal). These rocks are followed upward unconformably by Lower Eocene Ranikot Limestone with coal seams and Patala shales, and Upper Eocene marl and Laki Limestone. These are overlain unconformably by Miocene conglomerates and sandstones of the Siwaliks. The paper gives details of stratigraphy, lithology and structure of the area, together with the iron ore in the Lower Cretaceous belemnite-bearing beds and Lower Eocene coal.
Key words: Stratigraphy, coal, Makarwal, Trans Indus.

D/28. Danilchik, W. & Shah, S.M.I., 1975. Stratigraphic nomenclature of formations in the Trans-Indus Mountains, Mianwali District, Pakistan. USGS Report 75-622, 45p.

Key words: Stratigraphy, Trans Indus, Mianwali.

D/29. Danilchik, W. & Shah, S.M.I., 1976. Stratigraphy and coal resources of the Makarwal Area, Trans-Indus mountains Mianwali district, Pakistan. A USGS, Project Report Information Release, PK-60, 115p.

Please consult Danilchik and Shah (1967) above for further details.

Key words: Stratigraphy, Trans Indus, Mianwali.

D/30. Danilchik, W. & Tahirkheli, R.A.K., 1959. An investigation of alluvial sands for uranium and minerals of economic importance in Indus, Gilgit, Nagar and Hunza Rivers, Gilgit Agency, West Pakistan. Geological Survey of Pakistan, Information Release 11, 12p.

Uniformly low uranium content of 18 samples from widely distributed sample locations on the Indus, Gilgit and Hunza Rivers suggests that economically significant concentrations of uranium are not likely to be found in the alluvium of the upper Indus watercourses. Sands collected from boulder and cobble gravels in terraces and river beds contain 0.001 percent uranium or less. Wind- and water-deposited mantle sands contain 0.001 to 0.006 percent uranium. Spectrographic analyses of sand .and heavy mineral concentrates show no unusual or economically-significant concentration of rare or valuable elements.
Key words: Uranium, Indus, Gilgit, Nagar, Hunza.

D/31. Danishwar, S., 1990. Petrographic and chemical variation within rift related basic dykes in the Malka area (Lower Swat). M.Sc. Thesis, University of Peshawar, 72p.

Key words: Petrography, basic dykes, Buner, Swat.

D/32. Danishwar, S., 1994. Geochemistry of water and soil samples from Khishki and surrounding area, Nowshera and Charsadda district NWFP. M.Phil. Thesis, University of Peshawar.

Please consult the following account and Danishwar et al., 1995 for further information.
Key words: Geochemistry, water, soil, Nowshera.

D/33. Danishwar, S., Majid, M., Shah, M.T. & Haq, N., 1994a. Fluoride abundance in drinking water and related health hazards: A case study from Kheshki area, Nowshera district, NWFP, Pakistan. Geological Bulletin, University of Peshawar 27, 113-116.

Fluorides in food or drinking water have drastic effects on human health. High concentrations of fluorine in drinking water causes a disease called fluorosis. Geochemical study of groundwater and soil samples from the Kheshki area in Nowshera District, NWFP. (where from frequent cases of fluorosis are related) was carried out in February to June 1994. The results show high concentration of fluorides (0.00 to 41.2 pmm) in the groundwater samples from the studied area, which confirms fluoride toxicity. Necessary measures are required to be adopted to minimize the effect of this environmental deterioration.
Key words: Fluoride, water, health hazard, Nowshera.

D/34. Danishwar, S., Majid, M., Shah, M.T. & Haq, N., 1994b. Status and source of high fluorine contents in drinking water of Khishgi and surrounding areas, N.W.F.P, Pakistan. Symposium on Environmental Geology, Department of Geology, University of Peshawar.

Please consult the Preceding account and the following for further information.
Key words: Fluorine, drinking water, Nowshera.

D/35. Danishwar, S., Majid, M. & Shah, M.T., 1995. Mineralogy and Geochemistry of lacustrine deposits of the Kheshki area N.W.F.P. Pakistan. Journal of Science and Technology, University of Peshawar, 19, 33-38.

Kheshki area is a part of the Peshawar basin in N.W.F.P. and is covered by lacustrine deposits. A stratigraphic section north east of Kheshki, is studied in detail. These deposits predominantly contain minerals like quartz, calcite,

albite, orthoclase along with subordinate amount of chlorite, illite, tourmaline, fluorite, hornblende and vermiculite. Chemical analyses of the studied samples are compared with the average analyses of residual clay deposit s of various rocks. This study suggests that source rocks of lacustrine deposits of the Kheshki area are the acidic plutonic rocks of Warsak and Ambela granitic complex with influx of residual clay from the Nowshera Formation.
Key words: Mineralogy, geochemisrty, lacustrine deposits, Nowshera.

D/36. Danishwar, S. & Shah, M.T., 1997. Geochemistry of ground water and the source of contamination of fluoride in the drinking water of the Naranji area, District Swabi, NWFP, Pakistan. Pakistan Journal of Scientific and Industrial Research 40, 5-12, 83-00.

Inhabitants of the Naranji village are known for their yellow coloration of teeth throughout the Mardan Division. A general survey of the area shows prevalence of dental and skeletal fluorosis of varied degree in the village. A detailed geochemical analysis of ground water of the village indicates fluorite concentration of 13.5 mg L4 which is about 9 times more than WHO's maximum contaminant level. The source of high fluoride in drinking water is considered to be the alkaline rocks of Koga Complex. Tube well water should be supplied to the area in order to avoid the fluoride contamination.
Key words: Geochemistry, groundwater, fluorine, drinking water, Swabi.

D/37. Danishwar, S., Shah, M.T. & Majid. M., 1995. Abundance of fluoride and its source in drinking water of Kheshki and surrounding area, district Nowshera, NWFP, Pakistan. Geological Bulletin, University of Peshawar 28, 31-37.

Fluoride, if present in minute amount in human body, is beneficial for the growth of bones and teeth. Its excess is, however, very harmful and usually causes skeletal fluorosis. Few cases of skeletal fluorosis are reported in Kheshki and surrounding areas in NWFP. The drinking water of study areas has been, therefore, analyzed for the fluoride contents. It is noticed that this water has high concentration of fluoride. The source of fluoride enhancement in the drinking water of the area needs to be unraveled. For this purpose the water of Kabul river, rocks of Nowshera Formation and the lacustrine and soil samples of the area have been analyzed for fluoride. These media show elevated amounts of fluoride. The study suggests that in the lacustrine and soil deposits of the Kheshki and surrounding area the detrital minerals, which accommodate fluoride in their structure, are the main contributors of fluoride to be the drinking water.
Key words: Fluoride, drinking water, Nowshera.

D/38. Daru, N.D., 1910. Alum shale and alum manufacture at and near Kalabagh, Mianwali District, Punjab. Geological Survey of India, Records 40(4), 265-282.

Key words: Alum, Kalabagh, Mianwali.

D/39. Das-Gupta, H.C., 1915. Paleontological notes from Hazara. Journal of Asiatic Society of Bengal, New Series 11, 253-257.

Key words: Palaeontology, Hazara.

D/40. Daubekku, G., 1934. La esplorazione della region e fra I' Himalaia, occidentale e il Caracorum e Turchesan Cinese (1913–14). Mitteilungen Der Geologischen Gesellschaft In Wien Band, 2(1), 430p.

Key words: Himalaya, Karakoram, Chinese Turkestan.

D/41. Daubekku, G., 1939. Beitrage zur Geologie des Himalaya. Mitteilungen Der Geologischen Gesellschaft In Wien Band, 30–31.

Key words: Geology, Himalaya.

D/42. Davidson, C.F., 1962. Uraninite-scheelite placers of the river Indus. Economic Geology 57, 456-457.

Takes exception to the postulated long-distance transport of detrital scheelite and uraninite in sediments of the Indus river, Pakistan, noting evidence that scheelite is present in the alluvial deposits of many of the tributary valleys.
Key words: Uraninite, scheelite, Indus River.

D/43. Davidson, D.F., 1975. The geology and mineral resources of Kakul and Lagarband phosphate deposits, Hazara District, Pakistan. US Geological Survey/Geological Survey of Pakistan Information Release PK-63.

Based on field examinations and study of all available information concerning the phosphate deposits of the Kakul-Mirpur area, Pakistan, there is believed to be approximately 700,000 tons of minable phosphate rock of a grade of 30 percent or more P2O5 in the area. A similar study of available information of the Lagarban deposit suggests that there may be approximately 1,000,000 tons of minable phosphate rock containing 30 percent or more p2O5; in addition, approximately 1,500,000 tons of rock containing 20 percent to 30 percent p2O5 appear to be minable,
The total resource so far identified thus appear to be just over 3,000,000 tons of rock which may or may not be usable because of its chemical and mineralogical characteristics, but which can be mined. It must be pointed out that the figures given are based on very limited physical exploration, and equally limited analytical data. Further studies in the two areas are as likely to lessen as to increase them.
Key words: Mineral resources, phosphate, Kakul, Hazara.

D/44. Davidson, T., 1864. Notes on some Carboniferous and Jurassic brachiopoda collected by Capt. Godwin-Austin in north-western Himalaya. Geological Society of London, Quarterly Journal 20, p.387.

Key words: Carboniferous, Jurassic, brachiopoda, Karakoram, Himalaya.

D/45. Davidson, T., 1866. Notes on some Carboniferous brachiopoda collected by Capt. Godwin-Austin in the valley of Kashmere. Geological Society of London, Quarterly Journal 22, 39-45.

Key words: Carboniferous, Jurassic, brachiopoda, Himalaya.

D/46. Davis, I., 1984. Analysis of recovery and reconstruction following the 1974 Patan earthquake. In: Miller, K.J. (ed.). The International Karakoram Project 2, 323-342. Cambridge University Press.

The Patan earthquake was the most severe earthquake in Pakistan since the 1935 Quetta disaster. This paper will review some aspects of the relief and reconstruction activities with particular reference to earthquake damage and subsequent reconstruction in Dobair Bazaar and Patan. Detail is provided concerning shelter and housing provision, and in the light of the objectives of the Housing and Natural Hazards Projects, the paper discusses changes that may have to be made in construction techniques, thus reducing future vulnerability.
Key words: Earthquakes, disaster, Pattan, Hazara.

D/47. Davies, L.M., 1918. Problem of the Himalaya and the Indo-Gangetic Trough. Geographical Journal, 51, 175-1983.

Key words: Himalaya, Indo-Gangetic trough.

D/48. Davies, L.M., 1926. Remarks on Carter’s genus conulited (=dictyoconocides, nuttal) with descriptions of some new species from the Eocene of the Northwest India. Geological Survey of India, Record 59(2), 237-253.

Key words: Palaeontology, Eocene, India.

D/49. Davies, L.M., 1926. Remarks on the known species of conoclypeus with description of two new species from the Eocene of northwest India. Geological Survey of India, Record 59(3), 358-368.

Key words: Palaeontology, Eocene, India.

D/50. Davies, L.M., 1926. Notes on the geology of Kohat, with reference to the homotaxial position of the salt marl at Bahadur Khel. Asiatic Society of Bengal, Journal, Proceedings New Series 20, 207-224.

Key words: Rock salt, Bahadurkhel, Karak.

D/51. Davies, L.M., 1927. The Ranikot beds at Thal (North-West Frontier Province of India). Quaternary Journal of the Geological Society of London 83, 260-290.

Key words: Ranikot beds, Hangu, India.

D/52. Davies, L.M., 1930a. The fossils fauna of the Samana Range and some neighbouring areas. Part 1, Introductory note. Geological Survey of India, Palaeontologica Indica, Memoir (New Series) 15(1), 1-15.

Key words: Fossils, Samana Range, Hangu.

D/53. Davies, L.M., 1930.b The fossil fauna of the Samana Range and some neighboring areas. Part 6, The Paleocene foraminifera. Geological Survey of India, Palaeontologica Indica, Memoir (New Series) 15(6), 67-80.

Key words: Fossils, Samana Range, Hangu.

D/54. Davies, L.M., 1932. The genera Dictyoconoides Nuttall, Lockhartia nov., and Rotalia Lamarck: their type species, generic differences, and fundamental distinction from the Dictyoconus group of forms. Royal society of Edinburgh, Transactions, 57, 397-428.

The author recalls the facts regarding the rediscovery, in recent years, of Carter's genus Conulites (= Dictyoconoides Nuttall). He shows how, of seven species which have been referred to this genus, three always have numerous intercalary whorls in their spires, and four never have any such whorls. The association of these two groups together within a single genus has, so far as he himself is concerned, been due to the uncertainty hitherto existing regarding the type species cooki, whose spire was stated by Carter sometimes to show an intercalary whorl, but generally to be “single throughout.” Carter's original specimens, which had long been mislaid, have recently been found, however, and they all prove to belong to now familiar types, which invariably contain numerous

intercalary whorls in their spires. The author therefore separates the four species which do not possess such whorls into a new genus, Lockhartia.
The author next discusses the supposed identity of Dictyoconoides with Rotalia, and shows that the Rotalia must be judged by their type species R. trochidiformis. He shows that this species, among other characteristic features, invariably displays the structures called “astral lobes” by Carpenter and Brady, and is distinguished by the same from both Dictyoconoides and Lockhartia; while it is further distinguished from Dictyoconoides by the absence of intercalary whorls in its spire.
The author then compares the development of Rotalid forms, like the above, with that of piano-spiral ones like Nummulites and Assilines; and he finally shows the fundamental difference in structure between all these spirally wound types and those with an “end-on” development, like the Dictyoconus group of forms, with which some of them have been confused in the past.
Key words: Palaeontology.

D/55. Davies, L.M., 1938a. Eocene beds in Waziristan (India). Nature 142, p.296.

I SEE that Dr. Heron now accepts the fact that Ranikot beds exist in Waziristan. The evidence for this is, indeed, overwhelming, as I have pointed out elsewhere2. He says, however, that Dr. Coulson could not state whether the Khirthar overlaps on the Ranikot to the north of Kotkai, so perhaps I may be allowed to quote my own observations.
Key words: Palaeontology, Eocene, Waziristan, India.

D/56. Davies, L.M., 1938b. Quelques resultants de travaux recents sur 1’ Eocene du nord-ouest de 1’Inde. Societe Geologique de France, Comptes Rendus des Seances, 1938 (1-2), 22-23.

Key words: Palaeontology, Eocene, Waziristan, India.

D/57. Davies, L.M., 1940a. Geographical changes in northwest India during Late Cretaceous and Early Tertiary times. Abstracts with discussion, Geological Society of London, Quarterly Journal 96(2), 2-4 OR 1364, 11-14.

Key words: Geography, Cretaceous, Tertiary, India.

D/58. Davies, L.M., 1940b. Geographical changes in northwest India during Late Cretaceous and Early Tertiary times. Proceedings, 6th Pacific Science Congress (1939) 2, 483-501.

Key words: Geography, Cretaceous, Tertiary, India.

D/59. Davies, L.M., 1940c. Notes on the Himalayan rivers. Geological Magazine 77, 410-412.

This account gives the Physiographic relations between the rivers and the mountain ranges in the Himalayan region.
Key words: Physiography, rivers, Himalaya.

D/60. Davies, L.M., 1940d. Correlation of the Laki beds (Eocene, India). Geological Magazine 77, 252-253.

This paper gives correlation of the Eocene deposits of the Laki formation, included in these are those from northern Pakistan.
Key words: Stratigraphy, Eocene.

D/61. Davies, L.M., 1942. Tertiary Echinoidea of the Kohat-Potwar basin. Abstracts with discussion- Geological Society of London, Proceedings 1389, 7-9.

Consult the following account.
Key words: Tertiary, Kohat, Potwar.

D/62. Davies, L.M., 1943. Tertiary Echinoidea of the Kohat-Potwar basin (India). Quarterly Journal of the Geological Society, London 99, 63-77.

The author describes the results, to date, of work on the Tertiary echinoids of the Kohat district and northern Punjab. He recalls facts published in previous papers, and deals with collections more recently made. He outlines the stratigraphy of the northern basin, and shows how its echinoids help to correlate its elements with the early Tertiary deposits of Baluchistan and Sind.
A Number of Tertiary echinoids from the Kohat-Potwar basin have already been dealt with (Davies 1925, 1926A, 1927, 1937), but many more were collected during my last visit to India. An attempt is here made to summarize existing information on the subject.
By the expression "Kohat-Potwar basin" (cf. Davies 1940B, p. 489; 1940C, p. 209), is meant an area approximately covered by the Kohat district and the Potwar plateau. This region formed a fairly well-marked basin during late Cretaceous and early Tertiary times, when an arm of the Tethyan sea crossed the north-western corner of the Indian horst on its way to what is now southern Tibet (Davies 1940B). In the final phases of its marine history this basin showed increased individuality, owing to earth movements which severed its trans-Himalayan extension to the east and restricted its communications with Sind to the south.
Key words: Tertiary, Kohat, Potwar.

D/63. Davies, L.M., 1945. Age and origin of the salt deposits of Northwest India. Proceedings (section B), National Academy of Sciences, India 14(16), 225-232.

Key words: Salt deposits, India.

D/64. Davies, L.M., 1947. Age and origin of the salt deposits of northwest India. Proceedings (section B), National Academy of Sciences, India 16, part 2-4, 39-42.

Key words: Salt deposits, India.

D/65. Davies, L.M., 1950. Foraminifera and stratigraphy of the Indo-Afghan border. 18th International Geological Congress, Great Britain 15, 73-75.

Key words: Stratigraphy, foraminifera, Indo-Afghan border.

D/66. Davies, R.G., 1956. Petrographic notes on some rock types from the Panjal volcanic series of the Upper Lidar Valley of Kashmir. Geological Survey of Pakistan, Records 33 (3).

Key words: Petrography, Panjal volcanics, Kashmir

D/67. Davies, R.G., 1962. A green beryl (emerald) near Mingora, Swat State. Geological Bulletin, Punjab University 2, 51-52.

This is probably the first description of the emerald that occurs at Mingora.
Key words: Beryl, emerald, Mingora, Swat.

D/68. Davies, R.G., 1963. Some preliminary observation on the geological structure of the Hazara Slate Formation in the area of the Lora-Maqsood road. Geological Bulletin, Punjab University 3, 32-35.

The Hazara Slate Formation, according to Marks and Muhammad Ali (1961, p. 451, is composed of a thick succession of arenaceous and argillaceous rocks, largely fissile and well-bedded, but with true slates largely absent. The common alternations of sub-greywacke sandstones with silty and argillaceous rocks were likened by them to the Alpine Flysch; they drew attention to the graded bedding in the sandstones and to their smooth tops, flowcasts on the undersides, and worm tracks, and commented on the absence of ripple marks and current bedding. Muhammad Ali (1962, p. 32) suggested that the formation was in excess of 10,000 feet thick.
Key words: Structure, slates, Hazara.

D/69. Davies, R.G., 1964a. Some anomalous formations lying within the Attock Slates in the area immediately south of Attock, Peshawar Division, West Pakistan. Geological Bulletin, Punjab University 4, 101-102.

As a result of a photogeological examination of the country south of Attock, it was decided to carry out a ground check on the nature of certain bands of rock, apparently lying within the Attock Slates and giving rise to lighter tones than do the slates themselves. In August, 1964, a preliminary examination was made along the road which leads southwards from the western end of the Attock bridge and which cuts through the rock bands concerned. After passing through the slates themselves for about one thousand yards, the first band was found to form a narrow NW-SE trending ridge of a dark- coloured limestone which thickened to the south east. An exactly similar limestone occurred about half a mile to the south as a narrower band crossing the road with a W N W trend. Typical Attock slates or shales made up the area between the two limestones and also occurred again to the south of the southernmost band for about half a mile; they were followed, to the south by :

1. A band of white quartzite with some quartz veins.
2. Alternations of thinly bedded, purplish and greenish siltstones, rather fissile.
3. A white, fine-grained, compact limestone with a porcellanous appearance.

The total horizontal thickness of these (last mentioned) sedimentary rocks is about 2,000 feet; the dips are quite steep, but variable, and usually towards the south. Unit number 3 (above) is followed to the south by appreciable thicknesses of Quaternary superficial deposits belonging to the Upper Pleistocene and including silts, sands, gravels etc. The situation of these outcrops is given in Fig. I. An examination of the aerial photographs and a rapid scrutiny of the ground showed that the formations are present, not only on the west side of the Indus, but also on the east side, in the area shown by Cotter (1930), in his map, as Attock slate.

The formations extend far to the west, in the westerly trending ridges of Khattak and also to the east, in the hills north and west of Dakhner. It is seen that the structure is a rather tightly folded one with a mainly E-W trend and southerly dips; a number of very narrow folds are present which appear to be overturned towards the north. Small faults, often with N-S to NE-SW trends are present. A microscopic examination of thin sections of the more important lithologies present has led, in the case of the more northerly of the two limestone bands, to some rather unexpected results. The band concerned, which is narrow and enclosed by typical Attock slate, appears to have been plastically deformed and fractured and was found to be speckled with small Foraminifera. Among these, have been identified, by Mr. Riaz Ahmad, the following genera: Miscellanea, Numnulites and Assilina; fragments of gasteropods are also present, including Turitella. It is evident that this rock is of Palaeogene (probably Paleocene-Lr. Eocene, age). The rocks of the other, more southerly, outcrops do appear to be in a much better state of preservation than are the adjacent slates, and give the impression of being much younger, despite the overall complex structure. They seem to bear certain similarities to some of the rocks of the Abbottabad Formation of Marks and Ali (1962, p. 56).

It is thought that these outcrops represent in- folded and, perhaps, infaulted representatives of two formations of different ages, both of which are younger than the Attock slates. Careful mapping is required, both to the west, in the Khattak hills, and to the east towards Dakhner. This may be undertaken by this department when time permits.
Key words: Photogeology, Attock slates.

D/70. Davies, R.G., 1964b. The orthoconic nautiloids of the Kala Limestone-A correlation. Geological Bulletin, Punjab University 4, p.105.

The specimens extracted from the Kala limestone and described in the last issue of the bulletin (1963, p. 1-5), were re-examined by Dr. C. Teichert. He confirms the identification of Michelinoceras and feels that the specimen

compared with Harrisoceras may be correctly identified, although further information, about the annulosiphonate deposits and of the presence of an endosiphuncular tube, is needed. The identification of Arthophyllum is, however, regarded as incorrect, although the specimen is clearly one of the Michelinoceratidae. What appear to be the radial lamellar structures in the camera1 deposits are, in all likelihood, due to portions of crinoids having been introduced into the specimen during deposition. This identification has, therefore, to be withdrawn. The stratigraphic significance is, however, Jittle changed and it is still true to say that a Middle Palaeozoic age is indicated. Should, however, it be possible (by further collecting) to confirm the presence of Harrisoceras, the upper portion of the Lower Palaeozoic (Silurian) would probably be a more precise date.
Key words: Stratigraphy, palaeontology, Kala limestone.

D/71. Davies, R.G., 1965. The nature of the Upper Swat Hornblendic Group of Martin et al. 1962. Geological Bulletin, Punjab University 5, 51-52.

The Upper Swat hornblendic group crops out in a northeast-trending band in northern West Pakistan. Widely varied rock types ranging from granite to gabbro are cut by narrow, very coarse-grained pegmatoid veins and dikes. In thin section the rocks are seen to be mainly plutonic, although some metamorphic rocks are included, especially in the southern part of the outcrop area. Unpublished data from a gravity survey confirm that the zone under study is an overthrust.
Key words: Hornblendic group, pegmatoids, petrography, Swat.

D/72. Davies, R.G. & Ahmad, R., 1963a. The orthoconic Nautiloids of the Kala Limestone and the probable age of the Swabi Formation. Geological Bulletin, Punjab University 3, 1-5.

Some orthoconic Nautiloids from the Kala Limestone of the Swabi Formations are described, figured and discussed. It is considered that they indicate a Siluro-Devonian age for these formations which, prior to 1969, have usually been regarded as Pre-Cambrian. The broader stratigraphic implications are also discussed. This is the first time that definite Middle Paleozoic fossils have been recorded from West Pakistan.
Key words: Stratigraphy, orthonautiloids, palaeontology, limestone.

D/73. Davies, R.G. & Ahmad, R., 1963b. Fossils from Hazara Slate Formation at Bara Gali, Hazara, West Pakistan. Geological Bulletin, Punjab University 3, 29-30.

This is a preliminary report of some fossils from Hazara slates near Baragali. The samples were collected during a visit to the area in year 1962. The authors discussed these samples with other paleontologists and were of the view that further studies need to be carried out in the area to find any fossils which may help in deciphering the stratigraphy of the area. The authors have suggested that the Hazara slates are Lower Paleozoic rather than Pre Cambrian.
Key words: Fossils, Hazara slates, Baragali, Hazara.

D/74. Davies, R.G. & Gardezi, A.H., 1965a. The problem of the Triass in Hazara, West Pakistan. Journal of Scientific Research, Punjab University 1(1), 1-11.

Key words: Triassic, Hazara.

D/75. Davies, R.G. & Gardezi, A.H., 1965b. The presence of Bouleiceras in Hazara and its geological implications. Geological Bulletin, Punjab University 5, 23-30.

The discovery of ammonite, Bouleiceras of nitiscens Thevenin, below the base of the limestones which underly the equivalent of the Spiti shales in the Hazara Mesozoic succession, shows that the Trias is not represented in them and that they belong entirely to the Jurassic, in the Thai-Bara Gali section at least. The presence of the fossil indicates a Toarcian (Upper Liassic) age for the beds in which it is found. Some of the implications of its presence are discussed.

Key words: Palaeontology, ammonites, Hazara.

D/76. Davies, R.G. & Ghazanfar, N., 1967. A revision of the stratigraphy of the formations lying below the "Spiti Shale" in Hazara. Abstracts 18^{th} –19^{th} All Pakistan Science Conference, Jamshoro.

Key words: Stratigraphy, Spiti shale, Hazara.

D/77. Dawar, A.H., 1980. Geology of Issha area, Miran Shah, North Wazirsitan. M.Sc. Thesis, University of Peshawar, 25p.

Key words: Maps, geology, Miran Shah, North Waziristan.

D/78. Dawar, A.K., 1995. The tectonic stratigraphic net of the Black Mountain and its economic minerals. M.Sc. Thesis, University of Peshawar, 79p.

Key words: Stratigraphy, tectonics, economic minerals, Black Mountain.

D/79. Dawar, H., Wazir, U.A. & Wazir, M.A., 1985. Groundwater conditions, Parachinar plain. M.Sc. Thesis, University of Peshawar, 70p.

Key words: Groundwater, Parachinar.

D/80. Dawney, R. & Clavariono, J., 1994. Gold exploration and mineral analysis project (GEMAP) northern Pakistan. Abstracts, Second SEGMITE International Conference on the Export Oriented Development of Mineral Resources and Mineral Based Industries, 9-10.

The GEMAP project was designed to assist the Government of Pakistan develop its metalliferous mining sector through strengthening its mineral exploration and geochemical analysis capabilities.
The project is built around four components: Gold exploration in Northern Pakistan, centred on the Eurasian Plate and the Kohistan Arc complex and with associated field training of geologists from PMDC and SDA (A small component of the project with GSP is centred on the Makran of Balochistan).
Training of personnel in Pakistan and Australia in exploration philosophy, methodology and techniques, exploration management, analytical chemistry, mineralogy, cartography, mineral law formulation and administration. Provision of equipment for both field and laboratory activities. Provision of specialised analytical equipment and training of personnel to support exploration for lead/zinc. Integrated, early-stage exploration, including interpretation of satellite images and aerial photographs and systematic drainage sampling, is in progress to systematically cover the project area on a regional basis for the first time. Fast-track investigation of identified mineral occurrences is also being undertaken.
Exploration is primarily directed towards rapid identification of commercially viable deposits. Preliminary results to-date indicate a number of area requiring follow-up investigations.
In addition, the project is developing reliable data base (of world class standard) sufficient to demonstrate the mineral potential of Northern Pakistan and attract foreign and local, private sector investment in the mineral exploration and mining industry.
Key words: Exploration, gold, minerals, Eurasian plate, Pakistan.

D/81. Dawood, H., 1980. Geology of Warai Joga, Bunj area, District Dir. M.Sc. Thesis, Punjab University, Lahore.

Key words: Geology, maps, Buner.

D/82. Dawood, H., Hussain, S.S. & Chaudhry, M.N., 1996. Geology of Thana-Barikot quadrangle (sheet No. 43/2). Natural History Bulletin 2, 15-24.

Key words: Geology, mapping, Barikot, Malakand, Swat.

D/83. Dawood, S., Razaq, A. & Rahim, A., 1982. Stratigraphy, petrography and structural geology of Kohat pass. M.Sc. Thesis, University of Peshawar, 204p.

Key words: Stratigraphy, petrography, structure, Kohat pass.

D/84. Day, E.A., 1963. Case histories of the Dhulian and Balkassar oil fields, West Pakistan. ECAFE, Mineral Resources Development Series 20, 83-93.

Key words: Oilfields, Dhulian Balkasar, West Pakistan.

D/85. Deans, T. & Powell, J.L., 1968. Trace elements and strontium isotopes in carbonatites, fluorites and limestones from India and Pakistan. Nature 218, 750-752.

Carbonatites discovered in south-west Asia have typical trace elements, but some have unusually high ratios of strontium-87 to strontium-86. Related hydrothermal fluorites have quite different strontium isotope ratios and no distinctive trace elements, emphasizing difficulties in identifying ultimate sources of fluorites.
Key words: Carbonatites, trace elements, isotopes, fluorite, limestone, India, Pakistan.

D/86. Debon F., 1992. Geological setting of Eocene “Batura Granites” (Western Karakorum axial batholith, Northern Pakistan). Abstract Volume, 7th Himalaya-Karakoram Workshop, Department of Earth Sciences, Oxford University, England, p.108.

In the Karakorum, contrary to the Trans Himalaya, the existence of an Eocene plutonic episode remains poorly documented. Such an episode corresponds to the Batura plutonic unit (BAPU) of Debon et al. (1987) that only relies on a petrographic, geochemical and isotopic study of boulders from the terminal moraines of the Batura, Pasu and Ghulkin glaciers (draining the northern part of the Western Karakorum axial batholith, on the west of the Upper Hunza valley). The BAPU is dominantly made up of light-coloured and unfoliated biotite ± amphibole granites s.l. Based on the Rb-Sr whole-rock isotope analysis of five samples from the Batura moraine, it is Eocene in age [45 ± 7 Ma (5 samples) or 43 ± 3 Ma (4 samples), with an initial 87Sr/86Sr isotope ratio of 0.7055 ± 3 or 0.7056 ± 3 and a MSWD of 3.3 or 0.7 respectively]. It does not outcrop along the Hunza valley and differs In texture, composition and age from all the rock types [mainly foliated dark-coloured (meta) granodiorites] that compose the huge Mid-Cretaceous (95+41-6 Ma by U-Pb on zircons; Le Fort et al., 1983) Hunza plutonic unit of the Karakorum axial batholith, as also from the Upper Cenozoic dense network of peraluminous Ieucocratic dykes cutting through this unit.
The field trip I carried out in september 1991, in the framework of a joint EEC project, was mainly devoted to the BAPU, along the northern margin of the Western Karakorum axial batholith [Kuk-i Jerab (and Yashkuk) glaciers, south of the Chapursan valley; Batura glacier]. Among the observed features, the following ones seem of particular interest:
-The BAPU corresponds, but in part only, to the aplite-granite etc. group previously described and roughly mapped by Schneider (1957), Desio (1964), and Desio & Martina (1972).
-The BAPU displays sharp contacts and typically intrusive relationships with its Upper Palaeozoic (?) metasedimentary surroundings (e.g. Kuk-i Jerab glacier) as well as with the Cretaceous Hunza plutonic unit (Pup-i Shikorga, north of the Middle Batura glacier).
-The BAPU is composite. It comprises several (~. 2) individual plutons, up to more than 20 km in size. Texture and composition are rather homogeneous within a given pluton but vary significantly from pluton to pluton. Microgranular porphyritic textures are not rare.

-The BAPU may be associated with large coeval(?) gabbroic stook(s?) (Western branch of the Upper Kuk-i Jerab glacier).
In order to better constrain and understand the magmatic and geodynamic evolution of the Karakorum, complementary field and laboratory studies devoted to the BAPU are needed. In particular:
The possible extension of the BAPU on the east of the Upper Hunza valley (e.g. Distaghil Sar-Pumori Chhish area) has to be checked up
The emplacement age (s?) of the BAPU must be refined.
A comparison between the BAPU and the still very poorly-known Giraf syenite pluton, some 40 km north of the Karakoram axial batholith and maybe also Eocene in age (53 Ma according to a biotite Rb-Sr date of Desio et al., 1964), could be fruitful.
Key words: Geochemistry, geochronology, granite plutons, Batura, Karakaoram.

D/87. Debon, F., 1995. Incipient India-Eurasia collision and plutonism: the Lower Cenozoic Batura granites (Hunza Karakoram, North Pakistan). Journal of the Geological Society, London 152, 785-795.

Plutonism of the Karakorum, north of the India-Eurasia suture zone, comprises two major intrusive stages: the oldest, mid-Cretaceous, predates the collision; the youngest, Miocene, is post-suturing. In between, Lower Cenozoic plutonism, roughly syn-suturing and represented by the Batura complex, is made up of a few small and usually undeformed plutons. The complex has a subalkaline (i.e. intermediate between alkaline and calc-alkaline) and ferriferous association, dominated by light-coloured metaluminous and slightly peraluminous granites and adamellites with biotite ± amphibole ± titanite. Whole rock Rb-Sr isochron ages of 63 Ma (this study) and 43 Ma (Debon et al. 1987b) have been obtained for two plutons, with rather low initial 87Sr/86Sr ratios (0.7050, 0.7056). A comparison with granitoids of similar age from Kohistan suggests that the complex relates to the subduction of the Tethys ocean, and originates from a mantle source with but small crustal contribution, through a two-stage melting process. The apparently limited extent of Lower Cenozoic plutonism in the Karakorum contrasts with its wider development in the Transhimalaya and Kohistan. This contrast could be partly accounted for by changes in tectonic and magmatic subduction-related processes after the initial contact between India and Eurasia was established, in the NW Himalaya.
Key words: Tectonics, plutonism, Batura granites, Karakoram.

D/88. Debon, F. & Khan, N.A., 1993. Field Study of the Western Karakoram axial batholith along the Karambar valley (Northern Pakistan). Abstract, Volume, 8th Himalaya-Karakoram-Tibet Workshop, Vienna, 15.

The detailed study of the Karakoram axial batholith undertaken by different teams for the last ten years has shown its composite character. Different plutonic units, dominantly ranging in age from Cretaceous to Miocene, have been recognized. However, their inventory is far from being over, and their extent and relationships remain often ill-defined.
Our 1992 field trip in the Karakoram Range was mainly devoted to the Karambar valley (N. Pakistan), the choice of which was based on several grounds; - the Karambar valley offers a complete and easily accessible N-S section of the western axial batholith, perpendicular to its elongation; this section, hitherto poorly known (review in Casnedi, 1984), cross-cuts a cartographic plutonic “blank”, about 120-km long, separating two already investigated N-S sections of the batholith, namely the Yasin-Darkot and the Hunza-Batura sections. The study concerns a section around 40-km long, 28 of them for the batholith itself.
Along the Karambar valley, surrounding rocks of the batholith are essentially made up of metapelitic formations, usually trending WNW-ESE. Metamorphism is dominantly developed south of the batholith, where biotite-garnet metapelites are crosscut by a conspicuous swarm of diversified leucocratic dykes that could be hold responsible for their transformation into migmatites of the injection type. This migmatitic zone is about 4-km wide. More to the south, around 6-km far from the batholith, dykes almost completely disappear and metamorphism decreases abruptly (phyllites, slates).
At its northern and southern margins, the batholith intrudes metapelites along sharp, normal and steep contacts, roughly concordant at map scale. Metasedimentary xenoliths, a metre up to several decametres in thickness, are frequent close to either margins, particularly along the southern one where they occur within a zone some 700 m

wide. Metasedimentary rocks seem to be completely lacking in the internal part of the batholith. The huge screen, which, more to the west, divides the batholith into two branches, does not reach the Karambar valley.
Three major typos of plutonic rocks can be distinguished along the section studied: (1) strongly foliated biotite amphibole granodiorit, often rich in mafic enclaves, sometimes blastomylonitic, representing the westward continuation of the well-known mid-Cretaceous calc-alkaline “Hunza Granodiorite” (HG); (2) diversified foliated amphibole-biotite granite, locally porpyritic, corresponding to the mid-Cretaceous subalkaline “Darkot Pass Granite” (DPG); (3) various and more or less foliated fine grained rocks of acidic and intermediate composition (FGR). From north to south, the arrangement of the different units is: HG + metapelitic xenoliths (-0.2-km)/DPG, often porphyritic, + FGR + HG (~0.5-km)/DPG, often porphyritic, (~ ≤ 1.5-km)/DPG + FGR (+ HG) ~ ≥3.5-km)/FGR + HG (often as angular enclaves within FGR) (~ 5.5 km)/HG (~ 16-km)/HG + metapelitic xenoliths (~ 0.7-km). The different units usually display sharp and sinuous contacts. HG was emplaced before FGR, whereas FGR and DPG could be coeval.
On the whole, the section shows a very complex imbrication between the Hunza and Darkot Pass plutonic units, as also between them and the fine-grained igneous group (FGR), of uncertain affinity.
Numerous leucocratic dykes of various composition cross-cut the batholith. At least part of them were emplaced during or before the deformation(s) responsible for the foliation of their host granitoids. Their study, in relation with deformation and metamorphism, both within and out of the batholith, remains to be done and should be of particular interest.
Key words: Geology, Karakoram axial batholith, Karambar, Gilgit, Karakoram.

D/89. Debon, F. & Khan, N.A., 1995. Cretaceous Alkaline Granitoids in the Karakoram axial batholith (Karambar valley, N Pakistan). Abstract Volume, 10th Himalaya-Karakoram-Tibet Workshop, (ETH Zurich) Switzerland.

The Karambar valley offers a complete and easily accessible section of the western Karakorum axial batholith (Fig. 1). Following a reconnaissance study by Casnedi (1984), the section was mapped (Fig. 2), sampled, and briefly described by Debon & Au Khan (1993). Geochemical data (Table 1) allowed us to discover an alkaline complex in the northern part of the section. As in the Transhimalaya, subalkaline intrusives (i.e. intermediate between alkaline and calc-alkaline) are widespread in the Karakorum batholith (e.g. Le Fort, 1988). But it is the first time that alkaline granitoids are reported in this batholith.
The alkaline complex crops out for some five kilometres (Fig. 2). It is a heterogeneous body made up of medium-grained rocks associated with various fine-grained granitoids and mafic igneous enclaves.
Medium-grained rocks, at times deformed and foliated, are predominant and represent the most typical members of the complex. They form a widely differentiated group comprising metaluminous monzonites, quartz monzonites, granites and leucogranites (Table 1), with amphibole (ferro-edenite, .4, highly ferriferous biotite, ilmenite, clinopyroxene, ± allanite, apatite, sphene, zircon. They are two-feldspar granitoids, with plagioclase usually of the albite-type. They define a coherent alkaline (Fig. 3) and highly ferriferous series (Table 1), including some slightly peralkaline members [Al / (Na+K) <1]. From monzonites to leucogranites, differentiation is characterized by a rapid increase of the quartz content counterbalanced by a decrease of the mafic mineral and feldspar contents (Fig. 3). In the field, at the scale of the complex, this differentiation broadly progresses from south to north. Light-REE contents are high (LaN up to 549). REE patterns of the different rock types are comparable (Table 1; Fig. 4). They show a regular increase of the negative Eu anomaly from monzonites to leucogranites, most probably related to the decreasing abundance of feldspars. Four monzonites and two quartz monzonites have yielded a Rb-Sr isochron age of 87 ± 3 Ma (2σ), with an initial 8TSr/86Sr isotope ratio of 0.70439 ±8 (2σ) and a MSWD of 1.8 (when taking for calculations errors of 2% and 0.01% on the 8TRb/86Sr and 8TSr/86Sr ratios respectively) (Table 2; Fig. 5). The three analysed granites and leucogranites scatter below the isochron.
Working hypotheses include: (1) Emplacement of the Karambar alkaline complex could relate to the early Late Cretaceous collision between the Karakorum and Kohistan island arc along the Northern suture (Fig. 1). (2) Its alkaline character suggests a relationship with extensional processes, maybe linked to an oblique collision between the two domains, with subsequent strike-slip faulting. (3) Its initial 87Sr/86Sr isotope ratio is low (0.7044 ± 1), and undistinguishable from that of the mid-Cretaceous (109 ± 4 Ma) Darkot Pass granitoids (0.7044 ± 1; Figs 1, 5). Such features are compatible with a derivation of both plutonic complexes, one alkaline and the other subalkaline, from a similar mantle source, with but small crustal contribution.
Key words: Granitoids, Cretaceous, Karakoram axial batholith, Karambar, Gilgit, Karakoram.

D/90. Debon, F. & Khan, N.A., 1996. Alkaline orogenic plutonism in the Karakorum batholith: The upper Cretaceous Koz Sar Complex (Karambar, N. Pakistan). Geodinamica Acta 9(4), 145-160.

The Karakorum is located north of the India/Kohistan-Ladakh/Eurasia sutures. Along the Karambar valley, its axial batholith comprises four plutonic complexes. (1) The largest one represents the westerly continuation of the huge mid-Cretaceous calc-alkaline Hunts plutonic unit. This unit here displays a remarkable reverse zoning that would result from a differentiation at depth followed by multipulse intrusions. (2) A stock of subalkaline (i.e. intermediate between alkaline and calc-alkaline) granitoids (Warghut porphyritic granite). (3) A composite group of fine-grained granitoids. (4) The so-called Koz Sar alkaline complex (KSAC), a unique example of this composition of plutonism so far reported in the batholith. In addition, leucogranite dykes and rare alkaline mafic ones occur. The KSAC is a heterogeneous and more or less deformed body, ca. 5 km wide and possibly 20 km long, comprising two coeval groups of rocks. (1) Medium- to coarse-grained rocks are the most representative members of the complex. They consist of metaluminous to slightly peralkaline monzonite, quartz monzonite, granite and leucogranite, with iron-rich mafic silicates and Fe-Ti oxide. These subsolvus granitoids define a strongly ferriferous alkaline series. Five monzonite and quartz monzonite samples yield an isochron Rb-Sr age of 88 +/-4 Ma (Sr-87/Sr-86(i) = 0.70440 +/-7; MSWD = 1.7). (2) Fine-grained rocks (monzogabbro to quartz syenite) are compositionally comparable to the dark-coloured members of the preceding group. The KSAC was emplaced into a post-collisional environment resulting from the accretion, maybe at least since Aptian times, of the Kohistan island are to the Karakorum. Its alkaline character testifies to the development of extensional tectonics, a process compatible with an oblique collision and/or with the decrease, at the time of collision, of the convergence velocity between the two colliding terranes. Available data suggest that this alkaline complex (1) is late-orogenic, (2) is genetically-related to the nearby subalkaline granitoids and originates from the same mantle-source with a small crustal contribution, and (3) represents the ultimate member of the mid-Cretaceous subduction-related plutonism emplaced into the Karakorum continental margin.
Key words: Alkaline plutonism, tectonics, Cretaceous, Karakoram axial batholith, Karambar, Gilgit.

D/91. Debon, F. & LeFort, P., 1984. Chemical-mineralogical classification of plutonic rocks and associations. Examples from southern Asia belts. In: Xu, K.Q. & Tu, G.C. (eds.), Proceedings International Symposium on geology of granites and their metallogenetic relations, Nanjing University 1982. Science Press, Beijing, 293-311.

Key words: Plutonic rocks, chemical-mineralogical classification, Asia belts.

D/92. Debon, F., Le Fort, P., Dautel, D., Sonet, J. & Zimmermann, J.L., 1985. Plutonism in western Karakoram and northern Kohistan (Pakistan): a composite Mid-Cretaceous to Upper Cenozoic magmatism. Abstract Volume, 1st Himalayan Workshop, Department of Geology, University of Leicester.

The petrography, the chemical-mineralogical typology, and the ages of six plutonic units from the Karakoram axial batholith (Darkot Pass, Ghamu Bar, Batura and Hunza units) and the northern Kohistan (Gindai and Nomal plutons) are defined and compared based on field data and analyses of up to 78 samples (major elements, REE, Rb-Sr and K-Ar isotopes).
The Karakoram axial batholith is a composite body. Two major stages of intrusive emplacement occurred:
by Mid-Cretaceous times (ca. 110-95 Ma) with the emplacement of subalkaline, i.e. monzonitic, (Darkot Pass) and calc-alkaline (Hunza,? Ghamu Bar) units;
during Palaeogene, at least up to 43 Ma (Batura subalkaline unit). A strong tectonometamorphic event, recorded in the gneissification of the Cretaceous intrusive, happened between these two phases; it may be of Palaeocene age. P-T estimates of the highest metamorphic grade rocks of the Hunza unit have yielded values of 580-640oC and 5±0.5 kbar. Finally, a conspicuous network of aplo-pegmatitic dykes emplaced in the Hunza area, possibly from the Eocene up to the Upper Cenozoic with a maximum during the Middle Miocene (ca. 15 Ma).
These major magmatic stages are met again among the acidic intrusive and dykes of northern Kohistan: the first one as blastomylonitic tholeiitic plutons (Noma; ca. 102 Ma; Petterson & Windley, 1985), the second one as subalkaline

plutons (Gindai; ca. 58.5 Ma), and the third one as leucocratic dykes, of Oligocene age (ca. 30 Ma; Petterson & Windley, 1985).
These data may be related to the geodynamic evolution of the NW part of the India-Eurasia suture zone, this allowing to better constrain the major steps of this evolution. The partly synchronous closures, by N-dipping subduction, of the two Tethys branches assumed to have encircled the Kohistan arc in Upper Mesozoic times, may have generated both the Karakoram and the Kohistan intrusive. The northern branch very likely closed before the southern one. By the time of the second stage of intrusive emplacement (Palaeogene):
Kohistan and Karakoram had already collided, were welded and had suffered the same major tectonometamorphic event;
subduction of the southern Tethys floor beneath the welded Kohistan-Karakoram was still active;
however, collision between India and Kohistan-Karakoram may have already begun, particularly at the level of the Nanga Parbat promontory.
Key words: Plutonism, magmatism, Cretaceous, Cenozoic, Karakoram, Kohistan.

D/93. Debon, F., Le Fort, P., Dautel, D., Sonet, J. & Zimmermann, J.L., 1987. Granites of western Karakoram and northern Kohistan (Pakistan): A composite Mid-Cretaceous to Upper Cenozoic Magmatism. Lithos 20, 19-40.

The petrography, the chemical-mineralogical typology and the ages of six plutonic units, four from the Karakorum axial batholith (Darkot Pass, Ghamu Bar, Batura and Hunza units) and two of northern Kohistan (Gindai and Nomal plutons) are defined and compared based on field data and analyses of up to 78 samples (major elements, REE, Rb-S.sbnd;Sr and K/Ar isotopes). The Karakorum axial batholith is a composite body. Three major intrusive stages occurred: (1) around Mid-Cretaceous times (ca. 110-95 Ma) with the emplacement of subalkaline, i.e. monzonitic (Darkot Pass) and calc-alkaline (Hunza, ?Ghamu Bar) units; (2) during Palaeogene, maybe up to 43 Ma (Batura subalkaline unit). A strong tectonommetamorphic event, recorded in the gneissification of the Cretaceous intrusives, occurred between these two stages; it may be of Palaeocene age. *P-T* estimates of the highest metamorphic grade rocks of the Hunza unit have yielded values of 580–640°C and 5 ± 0.5 kbar; and (3) during Upper Miocene (ca. 9 Ma; Baltoro subalkaline unit; Debon et al., 1986c). In addition, a conspicuous network of aplo-pegmatitic dykes emplaced into the Hunza area, possibly from the Eocene up to the Upper Cenozoic with a maximum during the Middle Miocene (ca. 15 Ma). Most of these major magmatic stages are met again among the acidic intrusives and dykes of northern Kohistan: the first one as blastomylonitic tholeiitic plutons (Nomal; ca. 102 Ma; Petterson and Windley, 1985), the second one as subalkaline plutons (Gindai; ca. 59 Ma), and a third one as leucocratic dykes, of Oligocene age (ca. 30 Ma; Petterson and Windley, 1985).
These data may be related to the geodynamic evolution of the NW part of the India-Eurasia suture zone, thus allowing better constraints on the major steps of this evolution. The partly synchronous closures, by N-dipping subduction, of the two Tethys branches which are assumed to have encircled the Kohistan arc in Upper Mesozoic times, may have generated both the Karakorum and the Kohistan intrusives of Cretaceous and Palaeogene ages. The northern branch very likely closed before the southern one. At the time of the second intrusive stage (Palaeogene): (a) Kohistan and Karakorum had already collided, were welded and had suffered the same major tectonometamorphic event; (b) subduction of the southern Tethys floor beneath the welded Kohistan-Karakorum was still active; (c) however, collision between India and Kohistan-Karakorum may have already begun, particularly at the level of the Nanga Parbat promontory. Finally, it is emphasized that the intrusive processes continued in the Karakorum long after the collision (e.g., Baltoro granite).
Key words: Granites, petrography, mineralogy, Karakoram, Kohistan.

D/94. Debon, F., Zimmerann, J.L. & Bertrand, J.M., 1986. Le granite du Baltoro (batholite axial du Karakoram, nord, Pakistan); Une intrusion subalcaline d’age Miocene superior. Competes Randus des Seances de l’Academie des Sciences, Paris, 303, Series 2, 463-468.

Key words: Granites, glaciers, Baltoro, Karakoram.

D/95. Debon, F., Zimmerann, J.L. & Le Fort, P., 1996. Upper Hunza granites (North Karakorum, Pakistan): a syn-collision biomodal plutonism of mid-Cretaceous age. Competes Randus des Seances de l'Academie des Sciences, Paris, 323, Series 2, 381-388.

Key words: Granites, Hunza, Karakoram.

D/96. De Bruijn, H., 1986. Is the presence of the African family Thryonomyidae in the Miocene deposits of Pakistan evidence for fauna exchange? In: Proceedings of the Konionklijke Nederlandse Akademie van Wetenschappen. Series B, 89, 125-134.

Key words: Palaeontology, Miocene, Rodentia, Africa, Pakistan.

D/97. De Bruijn, H., Hussain, S.T., & Leinders, J.J.M., 1981. Fossil rodents from Murree Formation near Banda Daud Shah, Kohat, Pakistan, 1 and 2. Koninklijke Nederlandse Akacemie van Wetenschappen, Series B, 84 (1), 71-84.

Key words: Fossils, rodents, Murree Formation, Karak.

D/98. De Bruijn, H., Hussain, S.T. & Leinders, J.J.M., 1982. On some early Eocene rodent remains from Barbara Banda, Kohat, Pakistan, and the early history of the order Rodentia. Koninklije Nederlandse Akademie van Wetenschappen, Series, 85, 249-258.

Key words: Fossils, rodents, Murree Formation Kohat.

D/99. Decade, W., 1962. Devonian fossils from "opposite Reshun" in Chitral, Pakistan. Geological Magazine 92, 3-8 & 49-58.

Key words: Palaeontology, Devonian, Chitral.

D/100. De Filippi, F., 1910a. La spedizione nel Karakoram. Balogna, Zanichelli.

Key words: Expedition, Karakoram.

D/101. De Filippi, F., 1910b. The Exploration of H. R. H. the Duke of the Abruzzi to the Karakoram Himalayas. Geographic Journal 37, 19-30.

This is a summarized account of the Duke of the Abruzzi Expedition to the Karakoram Range.
Key words: Italian Expedition, Karakoram, Himalaya.

D/102. De Filippi, F., 1912a. La spedizione di S. A. R. il principe Luigi Amedeo di Savoia duka degli Abruzzi nel Karakoram e nell'Himalayaoccidentale (190-9). Zanichelli, Balogna.

Key words: Italian Expedition, Karakoram, western Himalaya.

D/103. De Filippi, F., 1912b. Karakoram and the western Himalaya (1909). Account of the Expedition of H. R. H. Prince L. A. Savoy, Duke of the Abruzzi. Constable, London.

Key words: Italian Expedition, Karakoram, western Himalaya.

D/104. De Filippi, F., 1915a. Rlazione preliminare sui lavori scientifici della Spedizione “De Filippi” al Caracorum, 1913-1914: cenni generali. Revista Geografia Italiana 22, 225-300.

Key words: Italian Expedition, Karakoram.

D/105. De Filippi, F., 1915b. Spedizione scientifica italiana in India ed in Asia, 1913-14. Geographic Journal 46, 85-105.

This is the English version of the above account.

Key words: Italian Expedition, Karakoram.

D/106. De Filippi, F., 1921. Publicazione dei resultati della Spedizione Italiana nell’Himalaya, Caracorum et b Turchestan cinese (1913-1914). Atti 8th Congress Geografica Italiano, 2, 1-6.

This is a bibliography of the publications coming out of the Italian 1913-1914 expedition to the Karakoram and Himalaya.
Key words: Italian Expedition, publications, Karakoram.

D/107. De Filippi, F., 1923. Storia della Spedizione scientifica italiana nel Himalaia, Caracorum e Turchestan cinese (1913-1914). Con capitol aggiuntivi di Giotto Daielli e J. A. Spranger, Zanichelli, Bologna.

Consult the English version of De Fillipi, 1932.
Key words: Expedition, Himalaya, Karakoram, Turkestan.

D/108. De Filippi, F. (Ed.), 1929. Relazione scientitiche Spedizione italiana de Filippi nell, Himalaia, Caracorum e Turchestan Cinese (1913–14). Ser. 1, 3 Volumes, Bologna.

Key words: Expedition, Himalaya, Karakoram, Turkestan.

D/109. De Filippi, F., 1930. Geological work of the Italian Expedition to the Karakoram, 1929. Geographic Journal 75, 402-411.

Consult the following account.
Key words: Italian Expedition, Karakoram.

D/110. De Filippi, F., 1932. The Italian expedition to the Himalaya, Karakorum and eastern Turkestan (1913–14). (English Transl.) Arnold, London.

The Italian Expedition 167 barren plateaux of the Karakoram were undertaken in the summer of 1914. The arrangements for "supplies and transport" needed to maintain so large an expedition, encumbered by elaborate and heavy scientific equipment, for months at a stretch on elevated ground utterly devoid of resources might well by themselves have sufficed to absorb the leader's energy and attention. All the same Dr. De Filippi managed to find time during those stays for a careful study of varied aspects of local life, customs, religious organization, architecture, etc. To this we owe inter alia the detailed description contained in chapter vi of the monastic institutions of Ladak, their structures, art, etc. Illustrated by a wealth of excellent photographs, which the skill of Colonel Antilli provided as for the rest of the book, this chapter helps the general reader perhaps better than any previous book of travel to realize the remarkable wealth of products of local industry, art, and craft to be found in that comparatively small portion of Western Tibet. Considering the very limited extent of arable ground, the adversity of climatic conditions at those great altitudes, and the very scanty population, the Census of 1911 gave for Ladak and adjacent tracts only some 36,511 Buddhists? The abundance of monasteries, shrines, religious monuments, and other structures, whether maintained or in ruins, must impress every visitor. By contrast with the Dard and Balti tracts, which also were once Buddhist, this wealth conveys a very instructive lesson to the antiquarian student as to the way in which peculiar cultural factors may affect the extent of structural and other remains of the past in neighbouring territories. A distinctive and very useful feature of the book is the diligent, one might almost say loving, care which Dr. De Filippi has bestowed upon notices of previous travellers' visits to those regions and of the records left of their observations and labours. All students interested in the geography and history of that fascinating borderland between India and Central Asia must feel grateful for this

Key words: Expedition, Ladakh, Baltistan, Karakoram.

D/111. Dehm, R. & Oettingen-Spieliberg, T., 1958. Palaontologische und geologische untersuchungen in Tertiar von Pakistan: Part 2, die Mitteleocanen Saugetiere von Ganda Kas bie Basal in nordwest Pakistan. Bayerische Akademie der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse, Abhandlungen 9, 54p.

Key words: Palaeontology, geology, Tertiary, Pakistan.

D/112. DeJong, K.A. & Qayum, A., 1981. Collapsed anticline in Kohat, south west Himalaya foothills, Pakistan. Geological Society of America, Abstracts with Program 13, p.437.

Key words: Structure, Kohat.

D/113. DellAngelo, L.N. & Tullis, J., 1989. Fabric development in experimentally sheared quartzites. Tectonophysics 169, 1-21.

A fine-grained quartzite was deformed under a combination of simple shear and axial compression to varying amounts of shear strain (1.3 to 2.9). The experiments were conducted at 800 °C, 1500 MPa, and an axial strain rate of 10^{-6}/s, in the dislocation creep regime. Shear zone boundaries were oriented at 45° or 30° to the compressor axis. The progressive development of deformation microstructures, including planar fabrics and c axis preferred orientations, was studied as a function of increasing shear strain. Elongate original grains define a foliation (S) which rotates from 45° to 0° to the shear zone boundary with increasing strain, producing a sigmoidal foliation in a single shear zone. A second foliation, invariant in orientation, is defined by elongate recrystallized grains, which lie at about 30°–40° to the shear zone boundaries. No C-surfaces, parallel to the shear zone boundaries, were observed. However, extensional crenulation cleavages (C'), defined by parallel zones of recrystallized grains as well as impurity and melt segregations, were observed even at low strain, lying at approximately 30° to the shear zone boundaries, and these could easily be mistaken for C-surfaces. C axis preferred orientations of original grains define symmetric type I crossed circle girdles at low strain ($\gamma < 2$) and asymmetric broad maxima at high strain ($\gamma > 2$), with the greater concentration of c axes in the direction of shear. These features are very similar to those observed in natural ductile shear zones.

Key words: Structure, shear strain.

D/114. Dell'Mour, R.W. & Rodgers, M., 1993. Deformation history and structural pattern within an exploration concession in the Eastern Potwar basin (NE Pakistan). Abstract, Volume, 8th Himalaya-Karakoram-Tibet Workshop, Vienna, 68-69.

Structural Data gained from fieldwork carried out in 1992, Satellite TM interpretation and seismic interpretation provides the basis for a Tectono-Kinematic interpretation of a small portion of the Eastern Potwar Plateau (Fig. 1).

The Potwar Basin is part of the Central Fold Belt of Pakistan, the northern portion of which forms part of the Himalayan foreland fold and thrust belt. This deformed belt is a product of the ongoing collision between the Eurasian and Indian plates which forms the northernmost element of the Indus Basin. Compressional deformation throughout the Himalayan foreland is taking place as the Indian Shield is overridden by sediments along its northern

margin. In the eastern Potwar deformation is distributed along a broader zone of northeast/southwest trending, tight to overturned anticlines separated by broader synclines.
Three phases of deformation have been observed within this compressional stress field (Fig. 2):
Phase 1: Thrusting and folding WNW/ESE
Phase 2: Strike-slip faulting (W)NW/(E)SE
Phase 3: Strike-slip faulting NE/SW
Intensity of deformation increases to the NW as expressed by the more intensely sheared and compressed Riwat anticline. The easternmost Kallar anticline shows only minor deformation of the crest owing to southeast directed thrusting which does not appear to have significantly disturbed the stratigraphic sequence.
The most extensively developed thrust zone has been observed on the eastern limb of the Buttar anticline although the poorly developed outcrop exposure prevents accurate identification on the Satellite images. Southeasterly directed thrusting over several hundreds of metres is likely and lithologic indicators in the kataclastic zone suggest probable detachment within the Kamlials or Chinji Formations.
Key words: Structure, Himalayan Foreland, Deformation, Potwar basin.

D/115. Dennell, R.W., 1992. Fossil and archaeological investigations of the Upper Siwalik of northern Pakistan. Abstracts, First South Asia Geological Congress, Islamabad, p.67.

Consult RW Dennell, 1997 also for further details.
Key words: Palaeontology, siwaliks.

D/116. Dennell, R.W., 1993. Evidence on human origin: A rediscovered source in the upper Siwaliks of northern Pakistan. Interdisciplinary Science Reviews 18, 379-389.

Consult RW Dennell, 1997 also for further details.
Key words: Human origin, siwaliks.

D/117. Dennell, R.W., 1995. Do human origins lie only in Africa? New evidence from northern Pakistan. Cranium, 12(1), 21-24.

Consult RW Dennell, 1997 also for further details.
Key words: Human origin, Pakistan.

D/118. Dennell, R.W., 1997. Palaeoanthropology of South Asia and the upper Siwaliks of Pakistan. Abstracts, 3rd GEOSAS Workshop on Siwaliks of South Asia, Islamabad. Geological Survey of Pakistan, Records 109, 69-71.

The Upper Siwaliks of northern Pakistan provide one of the longest and most detailed fluvial sequences for the Pliocene and Lower Pleistocene outside East Africa, the source of most early hominids. Although China and Indonesia have provided younger specimens of Horno erectus, there is scarcely any relevant fossil or archaeological evidence between these parts of East Asia, and East Africa, over 5,000 miles to the west. Northern Pakistan is, thus, one of the key areas for linking the early East African evidence for human evolution with the later East Asian material.
Recently palaeoenvironmental reconstructions have shown that in the late Pliocene, grasslands were continuous between northern China and Western Africa (Dowesett et a/. 1994). There was therefore no ecological barrier - such as the present-day Sahara- that prevented early hominoids from living outside East Africa. Other work from northern Pakistan indicates that the South Asian grasslands are substantially older than those of East Africa (Quade et al. 1989), and Upper Siwalik faunal remains also indicate the prevalence of a grassland fauna, broadly comparable to that of East Africa. Recent discoveries from Chad (Brunet et a/. 1995) indicate that hominids may have colonised the grasslands of Africa on a continental scale by 3 million years ago; if grasslands extended further east into Asia, they could also have occupied these. In the last two years, hominid remains from Indonesia (Swisher et a/. 1994), China (Wanpo et al. 1995) and Georgia (Gabunia and Vekua 1995) have been dated to 1.8 million years, raising

again the possibility that hominids had left Africa by 2 million years ago. Although each of these claims is highly contentious, an obvious working hypothesis that needs testing by fieldwork in northern Pakistan is that hominoids were living in South Asia by the late Pliocene/early Pleistocene (Denneil 1995).

Despite the potential palaeoanthropological importance of the Upper Siwaliks, they are still largely unexplored. As predicted as long ago as 1953 by Louis Leakey - the discoverer of Paranthropus boisei and Homo habilis at Olduvai Gorge, Tanzania - the discovery of early hominids in the Upper Siwaliks is only likely to result from several years, if not a life-time, of exploration (Leakey 1953: 214). Unlike East Africa, the Upper Siwaliks are a predominantly fluvial sequence formed by large perennial rivers. Although vertebrate fossil remains are often abundant and well-preserved, they tend to be highly dispersed, and rarely occur in the localised and repeated manner that often occurs in East Africa. Although carnivores are present, they tend to be very localised, and found mainly in association with very dense accumulations of fossils that probably represent their prey. For these reasons, fossil collecting surveys have to be conducted over a much larger area, and the discovery of fossils in one horizon rarely leads to the discovery of other material in the same place in later contexts. An additional problem is that the fossils found are overwhelmingly from animals more than 100 kg in weight- in other words, larger than most primates, including early hominids. Smaller animals are present, but found only after repeated and sustained searching.

A promising start to palaeontological and palaeoanthropological investigations of the Upper Siwaliks was made by the author, in collaboration with GSP and the Department of Archaeology, between 1985 and 1990, following on from earlier work conducted with the Department of Archaeology between 1980 and 1983 (Ashfaque and ul-Haq 1988, Denneli 1993, Jenkinson et a!. 1989). The Pabbi Hills, Gujrat District, proved to be extremely promising. Over 40,000 fossil remains were collected, of which ca. 15,000 were identifiable to taxon and/or skeletal element, from horizons between 0.9 and 2.0 million years old. Preservation was often extremely good, and three exceptionally rich fossil localities were excavated. One important result of this work is that GSP now has a useful comparative collection from the Upper Siwaliks that is available for other scholars to study. The fieldwork in the Pabbi Hills has also provided much useful information of the type and spatial distribution of fossil vertebrate remains in these kinds of fluvial landscapes.

Although hominid remains have not so far been found, indirect evidence that they were present in the late Pliocene and early Pleistocene was found in the form of stone tools. They oldest are those from Rawat, Southwest of Islamabad, which were dated initially to a minimum of 1.9 million years (Dennell et a!. 1988). In the light of subsequent analyses, this date has been revised to 2.4 million years, which implies that stone tool-making in Pakistan is of comparable age to that in East Africa (Rendell et a!. in press). Stone tools were also found in the Pabbi Hills, in the course of collecting fossil remains from the erosional surfaces of deposits between 1 and 2 million years old (Hurcombe and Dennel 1992), and one was found in situ in a horizon 1.2 million years old (Deniell et al. 1992). It is only a matter of time before more, and better, evidence is found.

These results are now being prepared for publication by the author, for a monograph to be completed in 1997. The author very much hopes to continue palaeoanthropological investigations of the Upper Siwaliks, both in the Pabbi Hills and in other promising areas. Fieldwork need not be on a large scale, providing it is sustained over several years. At some stage, early hominid remains more than a million years old will be found in the Upper Siwaliks of either Pakistan or India; however, they are unlikely to be found unless people look, and are prepared to search for several years.

Key words: Palaeontology, early hominids, fluvial sequence, siwaliks.

D/119. Derbyshire, E., 1984a. Sedimentological analysis of glacial and proglacial debris: a framework for the study of Karakoram glaciers. In Miller, K.J., The International Karakoram Project, Volume 1, 347-364. Cambridge University Press.

Sediments of mixed grain sizes exhibiting multimodal particle size curves (diamictons) are widely distributed. Processes producing them include glacial deposition, periglacial solifluction, debris slide and flow, mudflow, lahar flow (volcanic) and lacustrine and marine density currents (turbidities). Glaciers and ice sheets are a major source, deposits of this origin, mostly Pleistocene age, being found over about one third of the land area of the earth

Diamictons of glacial, periglacial and mud and debris flow origin are abundant in glaciated terrain, and they have considerable significance in the study of both pure and applied geomorphology.

This paper presents a framework for the study of Karakoram glacial and proglacial debries based on knowledge of the processes involved and the properties of sediments.

Key words: Sedimentology, glacial deposits, Karakoram.

D/120. Derbyshire, E., 1984b. Till facies and glacial regime in parts of High Asia: Karakoram and Tian Shan. In: R.O. Whyte (ed.), The Evolution of the East Asian Environment, University of Hong Kong, vol.1 (Geology and Palaeoclimatology), 84-110.

Key words: Glaciation, till, Karakoram, Tian Shan.

D/121. Derbyshire, E., 1989. The Karakoram glacial depositional system. In: Derbyshire, E. and Owen, L.A. (Eds.), Quaternary of the Karakoram and Himalaya, Zeitschrift fur Geomorphologie, Supplementeband 76, 33-73.

Key words: Glacial deposits, Karakoram.

D/122. Derbyshire, E., 1996. Quaternary glacial sediments, glaciation style, climate and uplift in the Karakoram and northwest Himalaya: review and speculations. Paleogrography, Palaeoclimatology, Palaeocology 120, 147-157.

Opinions on the extent and style of the Quaternary glaciations of the Karakoram and northwest Himalaya have ranged from restricted alpine-style glaciation to extensive inundation by montane ice caps, too overwhelming by sheet ice from the Qinghai-Xizang (Tibet) Plateau. The sedimentological and geomorphological evidence underpinning these contrasting opinions is used to integrate the sedimentary record with what is known about uplift and incision rates and broad-scale changes in the regional climate. By reference to the independent record of monsoon-versus westerly strength provided by the lacustrine and loess record of central and east Asia, increasing relative relief and topographical discordance are considered as influences upon glaciation style, glacier extents, and sediment budgets since the Middle Pleistocene. Ice extent may have progressively declined with increasing constraints on glaciation limits through time, but total ice volumes during glaciations may have shown less variation as valley systems enlarged in conditions of quasi-balance between uplift and incision.
Key words: Glacial sediments, climate, uplift, Karakoram, Himalaya.

D/123. Derbyshire, E., Li, J., Perrott, F.A., Xu, S. & Waters, R.S., 1984. Quaternary glacial history of the Hunza Valley, Karakoram mountains, Pakistan. In: Miller, K.J. (ed.), The International Karakoram Project, Volume 2, 456-495. Cambridge University Press.

The glacial landforms and glacial and paraglacial sediments, of the upper Hunza valley were mapped and resolved into a chronological sequence on the basis of morphostratigraphy, superposition, and degree of surface weathering. Sediments recognized include fluvial, galciofluvial, debris flow and lacustrine types together with tills of predominantly meltout origin. Sediments were analysed for particle size, projection roundness, surface texture, clast and microfabric and clay mineralogy. Weathering of surface boulders, degree of subsurface weathering, point compressive strength of boulder surfaces, desert-varnish development and percentage lichen cover were used to establish a relative chronology, the desert varnish index providing results consistent with other tests.
Eight glacial phases of varying magnitude were recognized, as follows:
A widespread glaciation, leaving isolated and deeply weathered erratics on summit surfaces above 4150 m altitude. This occurred when valleys were much less incised and is considered to be the earliest Pleistocene glaciation represented in the area and termed Shanoz.
(2) and (3) A second series of valley glaciations (c. 2500m) was recognized from weathered till remnants on benches in the main Hunza valley. These are attributed to the Yunz and Borit Jhell glacial stages, the former being older than 139, 000 yr BP (TL dating of lake silts) and correlated with the penultimate Pleistocene glaciation. The Borit Jhell glaciation filled the high diffluence cols and is dated (TL) as early last Pleistocene glaciation.
A stage of ‘expanded foot’ and minor valley glaciation (Ghulkin I); this is younger than 47,000 yr (TL). A more limited glacial advance of several km, blocking the Hunza River, occurred in the Ghulkin II stage; considered to be a late phase of the last Pleistocene glaciation. A glacial extension of 1-2 km left larger, well defined moraines with well varnished and weathered surfaces (Batura stage: considered mid-Holocene). A minor advance restricted to tributary valleys is indicated by mildly varnished moraines (Pasu I). It is bracketed by 14C dates of 840±80 and

325±60 yr BP. Minor oscillations of 19th and 20th centuries, which left sharp, unweathered metastable moraine forms and termed the Pasu II stage.
Key words: Glacial history, Quaternary, Hunza, Karakoram.

D/124. Derbyshire, E. & Miller, K., 1981. Highway beneath the Ghulkin. Geographical Magazine 53, 626-635.

Key words: Glaciers, Ghulkin.

D/125. Derbyshire, E. & Owen, L.A. (Eds.), 1989. Quaternary of the Karakoram and Himalaya. Zeitschrift fur Geomorphologie, Supplement Bd. 76.

Key words: Quaternary, Karakoram, Himalaya.

D/126. Derbyshire, E. & Owen, L.A., 1990. Quaternary alluvial fans in the Karakoram Mountains. In: Rachocki, A.H. & Church, M. (Eds.), Alluvial Fans - a Field Approach. Wiley, Chichester, 27-53.

Key words: Quaternary, alluvial fans, Karakoram, Himalaya.

D/127. Derbyshire, E. & Owen, L.A., 1997. Quaternary glacial history of the Karakoram Mountains and Northwest Himalayas: a review. Quaternary International. 38–39, 85–102.

The style and extent of glaciation in the NW Himalayas and Karakoram Mountains of Pakistan, and the Himalayas in NW India are reviewed. At least three glacial events, progressively less extensive with time, can be recognised in most regions. The timing and status of these glacial successions is poorly known. This is partially due to poor dating constraints, but also arises from a lack of adherence to strict stratigraphic procedures. Recommendations are made for a more rigorous approach to the study of Himalayan Quaternary glacial histories.
Key words: Glacial history, Quaternary, Karakoram, Himalaya.

D/128. Derbyshire, E., Owen, L. A. & Fort, M., 1987. Fabric and the problem of distinguishing glacial and non-glacial diamictations in the Karakoram and Himalaya. Abstracts, 3rd Himalaya-Karakorum Workshop, Nancy.

Key words: Diamictation, fabric, Karakoram, Himalaya.

D/129. Dercount, J., Zonenshain L., Ricov, I.E., Kazmir, V.G., Le Pichon, X., Knipper, A.L., Grandjacquet, C., Sborschchikov, I.M., Geyssant, J., Lepvrier, C., Pechersky, D.H., Boulin, J., Savosin, L.A., Sorokhtin, O., Westphal, M., Bezhenov, M.L., Lauer, L.P. & Biju–Duval, B., 1986. Geological evolution of the Tethys Belt from the Atlantic to the Pamirs since the Liassic. Tectonophysics, 123, 241–315.

We discuss nine palinspastic geological maps (Plates l-9) at 1/20,000,000 scale, which depict the evolution of the Tethys belt from the Pliensbachian (190 Ma) to the Tortonian (10 Ma). A Present structural map (Plate 10) is shown for comparison at the same scale with the same conventions. Our reconstructions are based on a kinematic synthesis (Savostin et al., 1986). a paleomagnetic synthesis (Westphal et al.. 1986) and geological compilations and analyses concerning in particular the western domain (Ricou et al., 1986), the eastern passive margins (Kazmin et al., 1986a), the eastern active margins (Kazmin et al., 1986b) the Black Sea-Caspian Sea basins (Zonenshain and Le Pichon, 1986) and the ophiolites (Knipper et al., 1986).

A key feature of our reconstructions is that we have adopted on the basis of the paleomagnetic synthesis, a unique 30”-counter-clockwise rotation of Apulia with respect to Africa between 130 and 80 Ma. Before 130 and after 80 Ma, Apulia was rigidly linked to Africa. Between 130 and 80 Ma. Apulia collided with Eurasia to the north and separated from Africa to the south. The separation of Apulia from Africa resulted in the formation of the Mesogea, which included the present Eastern Mediterranean. Concerning Iberia, the kinematic solution indicates that it moved with Africa between 110 and 54 Ma. Between 130 and 110 and between 54 and 35 Ma. Iberia moved independently of both Africa and Eurasia. Prior to 130 and after 35 Ma. Iberia belonged to Eurasia. In the Late Triassic, pieces of Gondwana collided with Laurasia and as a result the Paleo-Tethys Ocean disappeared. A Neo-Tethys ocean opened to the south within Gondwana and reached Pangea to the west where it ended in sphenochasm.
During the Mesozoic and Paleogene, most of the consumption of surface in the Tethys area was the result of subduction of oceanic or highly thinned continental crust although continental collision occurred as early as the Lower Cretaceous to the north of Apulia and the Middle Eocene to the north of Arabia. However, distension and oceanic accretion played a major role in redistributing oceanic space within the shrinking Tethys belt during the Mesozoic. A northern 3000 km long intra-continental east-west system of deep oceanic basins which we interpret as marginal basins s1 extended from the Valaisan trough and Carpathian basin to the west to the South Caspian basin to the east, between the Upper Jurassic and the Upper Cretaceous; it has since been progressively destroyed. A southern oceanic belt extended from the opening Central Atlantic to the shrinking Neo-Tethys. The connection between the Neo-Tethys and the Central Atlantic occurred first through a North Apulian seaway (the Maghrebian-Ligurian Sea) formed during the Jurassic and completely destroyed at the end of the Cretaceous.
At the same time as the North Apulian seaway was almost completely destroyed the accreting Neo-Tethys plate boundary was subducted below Eurasia. The accreting plate boundary system jumped to the south in the Middle-Upper Cretaceous; it resulted in the formation of a South Apulian seaway (Mesogea) and extended along the northern border of Arabia within the Neo-Tethys. This new accreting plate boundary was shortlived and its eastern Neo-Tethys portion was abducted over the Arabian margin at the end of the Cretaceous. During the Paleogene, the consumption of surface was mostly the result of oceanic subduction without oceanic accretion and at the beginning of the Neogene, with the collision of India with Eurasia, the Neo-Tethys ocean had essentially disappeared. From then on consumption of surface mostly occurred by shortening through continental collision processes. However, new oceanic accretion was initiated in the western Mediterranean. Thus, even in the Present mostly continental collision stage, the few remaining oceanic bodies (Mediterranean Sea, Black Sea and Caspian Sea, Gulf of Oman) still play a significant role in the establishment of the strain pattern.
Key words: Structure, tectonics, kinematics, Mesozoic, paleogene, tethys, atlantic, Pamirs.

D/130. Derry, L.A. & France-Lanord, D., 1996. Neogene Himalayan weathering history and river $^{87}Sr/^{86}Sr$. Impact on the marine Sr record. Earth and Planetary Science Letters 142, 59-74.

Clastic sediments in the Bengal Fan contain a Neogene history of erosion and weathering of the Himalaya. We present data on clay mineralogy, major element, stable and radiogenic isotope abundances from Lower Miocene-Pleistocene sediments from ODP Leg 116. Nd and Sr isotope data show that the Himalayan provenance for the eroded material has varied little since > 17 Ma. However, from 7 to 1 Ma smectite replaces illite as the dominant clay, while sediment accumulation decreased, implying an interval of high chemical weathering intensity but lower physical erosion rates in the Ganges-Brahmaputra (GB) basin. 0 and H isotopes in clays are correlated with mineralogy and chemistry, and indicate that weathering took place in the paleo-Gangetic flood plain. The 87Sr/ 86Sr ratios of pedogenic clays (vermiculite, smectite) record the isotopic composition of Sr in the weathering environment, and can be used as a proxy for $^{87}Sr/^{86}Sr$ in the paleo-GB basin. The Sr data from pedogenic clays shows that river $^{87}Sr/^{86}Sr$ values were near 0.72 prior to 7 Ma, rose rapidly to 2 0.74 in the Pliocene, and returned to I 0.72 in the middle Pleistocene. These are the first direct constraints available on the temporal variability of $^{87}Sr/^{86}Sr$ in a major river system. The high $^{87}Sr/^{86}Sr$ values resulted from intensified chemical weathering of radiogenic silicates and a shift in the carbonate-silicate weathering ratio. Modeling of the seawater Sr isotopic budget shows that the high river $^{87}Sr/^{86}Sr$ values require a ca. 50% decrease in the Sr flux from the GB system in the Pliocene. The relationship between weathering intensity, $^{87}Sr/^{86}Sr$ and Sr flux is similar to that observed in modern rivers, and implies that fluxes of other elements such as Ca, Na and Si were also reduced. Increased weathering intensity but reduced Sr flux appears to require a late Miocene-Pliocene decrease in Himalayan erosion rates, followed by a return to physically dominated and rapid erosion in the Pleistocene. In contrast to the view that increasing seawater $^{87}Sr/^{86}Sr$ results from increased erosion, Mio-Pliocene to mid-Pleistocene changes in the seawater Sr budget were the result of reduced erosion rates and Sr fluxes from the Himalaya. This contribution is on

samples collected in ODP rather than related directly to northern Pakistan, but it has relevance to the area and is therefore included.
Keywords: Neogene, clay mineralogy, weathering, Bay of Bengal, ODP, Himalaya.

D/131. Desio, A., 1930a. Geological work of the Italian expedition to the Karakoram. Journal of the Royal Geographical Society 75, 402-411.

Keywords: Geology, Italian expedition, Karakoram.

D/132. Desio, A., 1930b. Geological work of the Italian expedition to the Karakoram. Journal of the Royal Geographical Society 75, 505-518.

Keywords: Geology, Italian expedition, Karakoram.

D/133. Desio, A., 1930c. Itinerari percorsi durante La Spedizione Geografica Italiana al Karakoram 1929. Bollettino della Società geografica italiana, series 6,7, 163-181 and 277-300.

Key words: Italian Expedition, Karakorum, geography, geology.

D/134. Desio, A., 1936a. La Spedizione Geographica Italiana nel Karakoram, Storia Del viaggio e resultati Geographici, in collaborazione can S.A.R. Aimone di Savoia Aosta, Arti Crafiche Bertarelli, Milano. Vol. In 8 di 620p.

This is a detailed description of the journey and results of the Italian Geographic Expedition to the Karakoram undertaken during 1929. The 620 page volume contains 254 figures, 39 pictures and four topographic maps.
Key words: Italian Expedition, Karakoram, geography.

D/135. Desio, A., 1936b. La Spedizione Geografica ltaliana al Karakoram (1929), Arti Crafiche Bertarelli, Milano.

The preceding five papers by A. Desio describe the activities of the 1929 Italian expedition to the northern part of the central Karakoram mountain range, located in present day Pakistan. The expedition concerned various aspects of the geography and geology of the region.
Key words: Italian Expedition, Karakoram, geography, geology.

D/136. Desio, A., 1940. Il Baltoro. Le Alpi 59, 477-478.

This is a description of the Baltoro Glacier and its basin.
Key words: Glaciers, Baltoro, Karakoram.

D/137. Desio, A., 1953~1955. The Italian Expedition to the Karakoram (Himalaya): preliminary geological petrographical information on the. basin of the Baltoro glacier.

After a reference to previous information, the authors give a preliminary description of the geological structure of the Baltoro basin, with particular stress on the main petrographic problems. The geological structure of this area is characterized by a big pluton of granitic nature outcroping widely in the western section. The metamorphic rocks (prevalently gneiss) of the K2 and Falchan Kangri are directly related. Another smaller intrusive mass, of a dioritic facies, occurs In the later group, while the semimetamorphic series, of sedimentary origin, and referable to the upper Paleozoic and Mesozoic, form the main part of the Gasherbrums group and a part of the Falchan Kangri and of the western slopes of the Godwin Austen glacier.
Key words: K2 gneisses, Baltoro, Structural geology.

D/138. Desio, A., 1953a. Uno sguardo al Pakistan, il paese tagliato in due, L' Universo, Anno 33, No.6, 837-841.

Key words: Pakistan.

D/139. Desio, A., 1953b. Sull' eccezionale avanzamento di un ghiacciaio himalayano. Rendiconti dell' Accademia Nazionale dei Lincei, Ser. 8, 15, 253-255.

Key words: Glaciers, Himalaya.

D/140. Desio, A., 1953c. La triade dei colossi: Everest (8840 m), K^2 (8611 m), Kanchenjunga (8585 m). Riv. Mensile del Culb Alpino Itaiano 71, 3-8.

Key words: Everest, K2, Kanchenjunga.

D/141. Desio, A., 1954a. An exceptional glacier advance in the Karakoram-Ladakh region. Journal of Glacialogy, 2 (16), 383-385.

Key Words: Glaciology, Karakoram, Ladakh.

D/142. Desio, A., 1954b. La mia ricognizione al Karakorum del 1953. La Ricerca Scientifica 24, 253-262.

Key Words: Reconnaissance, Karakoram.

D/143. Desio, A., 1954c. La mia recognizione preliminare al K 2 (Karakorum occidentale) nel 1953. Riv. Mensile del Culb Alpino Ital. 73, 3-14.

Key Words: Reconnaissance, Karakoram.

D/144. Desio, A., 1954-1957. La conquista del K2. (Italian editions of 1954, 1955, 1956, 1957), Garzanti Milano 1988 edition, Marsilio ed. Venezia. English, Ger, French, U.S.A., Spanish, Swedish, Hungarian, Russian, Japanese editions.

Key words: K2, Italian Expeditions, Karakoram.

D/145. Desio, A. (Leader), 1954-1991. Italian Expeditions to the Karakorum (K2) and Hindukush. Scientific Reports, ISMEO, Melano.

The Italians have contributed to our understanding of the geology, geography, and other aspects of the Karakoram Mountains more than any other. Apart from the earlier voyages for scientific work, contributions of which are reported in this work at different places, a series of expeditions were conducted in the leadership of Professor Ardito Desio. The following account is a verbatim copy of the preface that Desio wrote for Volume 1.

This volume is the ninth in the series of Scientific Reports of the Italian Expeditions to the Karakorum and Hindu Kush organized under Desio's leadership from 1953 to 1975. The list of contents of this collection, which is given at the beginning of each volume, gives the first subject as geography, which means that this volume should in fact have been published first. However, for a number of reasons which will be mentioned later, it is one of the last to be printed. Here below are the titles of the eight volumes already published.

I.—GEOGRPHY

Vol. 1: 1st part – Geographical features of the Karakorum by A. Desio.
2nd part – Meteorological observations of Desio's 1954 Expedition by F. Petrucco.
3rd part – Geodetic and topographic survey of Desio's 1954 expedition.

II. - GEOPHYSICS
Vol. 1: Geophysics of the Karakorum by Antonio Marussi, 1954.

III. – GEOLOGY – PETROLOGY
Vol. 1: Geology and Petrology of Haramosh-Mango Gusor Area by Bruno Zanettin, 1964.
Vol. 2: Geology of the Baltoro basin by Ardito Desio and Bruno Zanettin, 1970.
Vol. 3: Geology of Central Badakhsan (North-East Afghanistan and Surrounding Countries) Ardito Desio Editor, 1975.
Vol. 4: Geology of the Shaksgam Valley, North-East Karakorum, Xinjang (Sinkiang) by Ardito Desio, 1980

IV. – PALEONTOLOGY – ZOOLOGY – BOTANY
Vol. 1: 1st part – Fossils of Karakorum and Chitral by M. Amoit, R. Ciry, N. Fantini Sestini, I. Premoli Silva, C. Rossi Ronchetti, P. Sartenaer, A. Vandercammen, A. Von Schuppe, C. Zanin Buri.
2nd part – Results of the study of the entomological collection of the Karakorum and Hindu Kush (1954-1955) by E. Gridelli and G. Muller with collaborators.
3rd part – List of Spermatophyta collected in the Karakorum above 4000 m (1953-1954) by L.H.J. Williams, 1965.
Vol. 2: Fossils of North-East Afghanistan: Carboniferous fossils by A. von Schouppe – Triassic Fossils by P.D.W. Barnard – Jurassic fossils by C. Rossi Ronchetti – Cretaceous and Paleogene fossils by A. Berizzi Quarto di Palo and I. Premoli Silva, 1970.

V. – PREHISTORY – ANTHROPOLOGY
Vol. 1: Prehistoric research in North-Western Punjab – Anthropological research in Chitral by Paolo Graziosi, 1964.

As can be seen from the list given above, not all the subjects planned were carried out in a uniform manner. This was the result of the fact that some of the research, such as the geological work, was given precedence. In actual fact other work, such as the geophysical research would have benefited from further collaboration in the scientific reports. It should be remembered with regard to this, that the only volume published on this subject refers principally to the results of the 1954 expedition, while the same research in fact also carried out geophysical research during the 1955 and 1961 expeditions. Only brief notes actually appeared on these expeditious though a further volume was to have been published on this subject. Again, in the Prehistory-Anthropology section, a second anthropological volume was planned on the population of the Hunza valley by Prof. Paolo Graziosi. Unfortunately, in 1954 when he tried to reach me a month later, he was unable to obtain a permit to travel to the valley.
I should like to point out that while the previous seven volumes of this series deal with the scientific results of my expeditions in the Karakorum and Hindu Kush area from 1953 onwards, the eighth book reports on an area I explored back in 1929 in the capacity of geographer and geologist of the Italian Geographical Expedition led by Aimone di Savoia-Aosta, Duke of Spoleto, and organized on behalf of the Italian Royal Geographical Society and the Milan City Administration. An official volume on this expedition was published in 1936 with the title 'La Spedizione Geografica Italiana nel Karakorum – 1929. Storia del viaggio 'Risultati Geografici'.
The reason why I thought it appropriate to publish the volume on the valley Skaksgam lies in the fact that the geological results of the expedition had been mentioned very briefly in the 1936 volume, which was basically devoted to illustrating the geographical results. On the other hand, I was in fact the only geologist on that expedition and it was therefore my task to detail the results achieved in field, despite the fact that there was very little to add in the way of new discoveries as I stated in the preface to the above volume. This is why I decided to include in the collection a work which refers to an earlier expedition, than those I organized.
Staring from 1953, I organized and led several scientific explorations in the Karakorum and Hindu Kush and more precisely in 1953, 1954, 1955, 1961, 1962, 1973, and 1975. The last two had purely geological aims, while the 1954 expedition had two programmes to fulfill: a climbing programme which led to the first ascent of K2, and a scientific programme which was carried out not only in the Baltoro glacier basin and in the Stak valley, an affluent of the Indus, but also in the territory, lying between the two.
The volumes so far published do not illustrate all the results of research carried out in that area. Owing to intense scholastic and scientific duties, nothing has been published on the far western area of the Karakorum and on the

eastern side of the Hindu Kush though I and some collaborations have published preliminary reports. Some information, however, is included in the volumes dedicated to Paleontology.
I am now planning the tenth volume of this collection to be devoted to the results of glaciological research carried out during my expeditions in that area of Central Asia which have so far only been occasionally and sporadically reported.
The purpose of this volume is to report the results of observations and measurements of different types made mainly during the 1954 expedition. The geodetic and topographic measurements carried out by the captain (now general) Francesco Lombardi of the Italian Military Geographical Institute are of particular importance. The Institute was entrusted with the task, and theirs is the merit of drawing up the four topographic maps included in this volume.
I considered it useful to include the meteorological data as a contribution to knowledge of the climate of the region as recorded day by day at the base camp of K2 and in the surrounding areas during the months of May, June, July and August of 1954, principally at an altitude of 5000 m. The data was processed by Dr. Francesco Petrucco during her undergraduate studies under the direction of Prof. Silvio Polli, professor of Technical Physics and Climatology of the University of Trieste.
Before concluding this preface I should like to thank all those who have collaborated on this volume, in particular the authors of the two chapters mentioned above and the Italian National Council of Researches and the Finmeccanica which contributed to financing this volume.

Ardito Desio

Key words: K2, Italian Expeditions.

D/146. Desio, A., 1955a. Le ricerche scientifiche della spedizione Italiana al Karakoram K-2 1954. Rendicorto dell' Accademia Nazionale dei Lincei 34, 9p.

Key Words: Italian Expedition, Karakoram.

D/147. Desio, A., 1955b. Nuovi ritrovamenti di calcari fissiliferi del Paleozoico superiore nel bacino del Baltoro (Himalaya-Karakorum). Rendicorto dell' Accademia Nazionale dei Lincei, ser. 8ª, vol. XVIII(G), 587-598, Roma, giugno 1955.

This is an account of paleontology of the Baltoro basin sedimentary rocks. Calcareous fossils of Early Paleozoic are described.
Key Words: Paleozoic, Baltoro, Karakoram.

D/148. Desio, A., 1955c. The ascent of K2. The Geographical Journal, vol CXXI, pte 3ª, 261-273pp., 6 fig., London, September 1955.

The Italian 1954 Expedition under the leadership of Ardito Desio was the first to climb K2, the highest peak (8611 m) of the Karakoram, second only to the Mount Everest (8840 m) in the Nepal Himalaya. The conquest was, indeed, unique because K2 is considered a very difficult peak from the point of view of mountaineering. This is one of several narratives of the expedition to which references are given above and in the following.
Key Words: K2 ascent, Karakoram.

D/149. Desio, A., 1956. Cretaceous beds between Karakorum and Hidu Kush Ranges (Central Asia). Review Italiana Paleontologica 65, 221-229. 28th International Geological Congress, Mexico 7, 345-354 (in Italian)

Key Words: Cretaceous, Karakaoram, Hindukush.

D/150. Desio, A., 1958a. Il Cretaceo fra il Karakorum e l'Hindu Kush (Asia Centrale). 20th International Geological Congress, Mexico City, 7, 345-354.

Fossiliferous rocks of the Cretaceous age occur in several areas in northeastern Hindukush, Kohistan (Yasin) and Karakoram ranges. The author describes and compares these rocks. For further information, consult Desio (1959) in the following.
Key Words: Cretaceous, Karakaoram, Hindu Kush.

D/151. Desio, A., 1958b. La Spedizione Italiana al Karakorum e la conquista del K 2. Op. in 8º di 24p, 8 fig., Cairo.

For further information, see Desio, 1955c.
Key Words: Italian expedition, Karakaoram.

D/152. Desio, A., 1959. Cretaceous beds between karakoram and Hindu Kush ranges. Rivista Italiana di Paleontological e stratigrapica 45 (3), 211-229.

This paper describes the occurrence and nature of the Cretaceous beds in the "border" area between western Karakoram and eastern Hindukush. The author describes the Cretaceous sequence in the Yasin area , together with the fossils which were studied by his colleagues. The following species were studied:
Horiopleura haydeni DOUVILLE
Praerdiolites gilgitensis DOUVILLE
Adiozoptyxis coquandiana (D'ORBIGNY)
Adiozoptyxis renauxiana (D'ORBIGNY)
Nerinea vogtiana DE MORTILLET
Nerinea desioi FARIOLI MIRELLI
Rhabdophyllia cf. gracilis DE FROM
Isastrea cf. regularis DE FROM
Orbitolina discoidea GRAS
Key words: Cretaceous beds, Yasin Group, Hindu Kush, Karakoram.

D/153. Desio, A., 1960. Sull'estensione dei plutoni granitici nell'Karakoram e nell'Hindu Kush (Asia Centrale), Rendicorto dell' Accademia Nazionale dei Lincei 8, 28(6), 783-786.

This paper presents information on the extension of granitic plutons of the Karakoram and Hindukush mountain ranges. Ages for various of the plutons are shown in Desio et al. 1960 below.
Key Words: Granitic plutons, Karakaoram, Hindukush.

D/154. Desio, A., 1961. Resti glaciali Quarternari nelli valli Panjkora, Chitral e Swat, (Pakistan Nord-Occidentale. Bollettino del Comitato Glaciologico Italiano, 9, Ser.2, (1959-60), Parte I, 3-10, 4 fig.

The valleys of Chitral, Dir and Swat, now drained by the Kunhar, Panjkora and Swat rivers, respectively, were extensively affected by Quaternary glaciation. This is one of the earliest account of glaciation (morphology, glacial deposits, etc.) in the three valleys.
Key Words: Quaternary glaciation, Panjkora, Swat, Chitral.

D/155. Desio, A., 1962. Appunti geologici preliminary sui bacini dei ghiacciai Biafo e Hispar (Karakorum-Himalaya). Bollettino della Societa Geologica Italiana 81, fasc. 1, 69-84, 6 fig.

The Biafo and Hispar are two of the longest glaciers of the Karakoram Range. This is a preliminary account of the geology of the basins of the two glaciers. After having shortly examined the precedent studies on the considered territory, the Author illustrates compendiously the geological constitution of the basins of the Biafo and Hispar glaciers, by reporting the data which he collected in 1954 on occasion of a trip from the village of Askole as far as the Hunza town, crossing the Hispar pass.

The determinations of the samples· collected along the way were made by B. Zanettin. The lower portion of the Biafo basin is composed by a metamorphic formation chiefly formed by gneiss, garnetiferous mica schist and crystalline limestone (Dumordo Formation). The upper portion is formed by granite followed by bands of migmatite. The Dumordo Formation appears also in the lower valley of the Hispar glacier. Upstream prevails another metamorphic formation, richer in gneiss (K2 Gneiss), and poorer in crystalline limestone. In the north-western portion of the Hispar basin and south of the Hispar pass outctop the granite, here too followed by more or less thick bands of migmatite. The formations are folded; the Dumordo Formation more intensely than the other ones. In the Biafo basin there is a sequence of anticlines and synclines roughly directed east-westwards. Other folds with the same direction have been identified in the lower Hispar.
Key Words: Geology, glaciers, Biafo, Hispar, Karakoram.

D/156. Desio, A., 1963a. Notizie preliminary sulla "Spedizione Desio al Karakorum 1962" Notiziario de "La Ricerca Scientifica" vol. 3(5), 485-488.

The 1962 Italian Expedition to the Karakoram was led by the author. Here he gives a preliminary account of it.
Key Words: Italian 1962 Expedition, Karakoram.

D/157. Desio, A., 1963b. Review of the geologic "Formation" of the western Karakoram (Central Asia). Rivista Italiana di Paleontologiae i Stratigrafia 69, 475-501.

The geology and stratigraphy of the rocks of western Karakoram is presented.
Key Words: Geology, stratigraphy, Karakoram.

D/158. Desio, A., 1963c. Travels in the Karakorum. Pakistan Quarterly, XI(3), 14-21, 13 fig., Karachi.

This is a popular paper describing the travels of Ardito Desio and his many expeditions in the Karakoram, Hindu Kush, and Himalayan ranges.
Key Words: Tourism, travels, Karakoram.

D/159. Desio, A., 1963d. Qualche osservazione sopra un recente studio geologic sul Karakorum (Asia Centrale). Rend. Accadme Nazionle de Lincei, series 8a, 34, 358-363.

Key Words: Tectonics, Karakoram.

D/160. Desio, A., 1964a. Tectonic relationship between the Karakoram, Pamir, and Hindu Kush (Central Asia). 22nd International Geological Congress, New Delhi, 11, 197-213.

Key Words: Tectonics, Karakoram, Pamir, Hindukush.

D/161. Desio, A., 1964b. Geological tentative map of the western Karakoram 1:500 000. Dipartimento di Scienze della Terra, Universita di Milano.

This is the first geological map of the large area. It covers the area bounded by 74º-77º 15' East longitude and areas in Karakoram Range lying to its north. Brief notes on a large numbers of lithostratigraphic units are given in 35º15'-37º North latitude. The geological sketch map covers Nanga Parbat and adjacent areas and is presented together with ages. A list of pertinent references has also been given.
Key Words: Geological map, Nanga Parbat, Karakoram.

D/162. Desio, A., 1964c. Sulla presenza del Cretaceo fossilifero nel vallone del Burji-la presso Skardu (Baltistan), Asia Centrale. Rendiconti Accademia Nazionale dei Lincei, series 8^a, 37, 360-363.

Key Words: Cretaceous, fossils, Skardu.

D/163. Desio, A., 1965a. Sulla struttura geologica dell' Asia Centrale. Rendiconti Academia Nazionale dei Lincei 38, 780-786.

This is a regional account of the geo-tectonic framework of the Central Asia, including northern Pakistan. Tectonic zones and major faults are recorded.
Key Words: Structural geology, Tectonics, Central Asia.

D/164. Desio, A., 1965b. On the tectonic connection between Pamirs and Hindukush. In: D.N., Wadia Commermorative volume. Mining and Metallurgical Institute of India, Calcutta, 716-721.

Key Words: Tectonics, Pamirs, Hindukush.

D/165. Desio, A., 1965c. Introdution. In: Italian Expiditions to the Karakorum (K2) and Hindu Kush (A. Desio leader). IV-Paleontology-Zoology-Botany, Volume 1, 1-9. Brill, Leiden.

The many Italian Expeditions to the Karakoram and Hindukush ranges have resulted in a wealth of information contained in a very large number of papers. This particular volume deals with paleontology, zoology and botany. The monumental contributions are also listed under "Italian Expiditions to the Karakorum (K2) and Hindu Kush (A. Desio leader)".
Key Words: Italian expedition.

D/166. Desio, A., 1966. The Devonian system in Mastuj valley (Chitral, NW Pakistan). Rivista Italiana di Paleontologiae e Stratigrafia 72, 293-320.

Key Words: Palaeontology, Devonian, Mastuj.

D/167. Desio, A., 1974a. Geological reconnaissance in the middle Indus valley between Chilas and Besham Qila (Pakistan). Bollettino della Societa Geologica Italiana. 93, 345-368.

The geology of the area is described, together with petrographic notes. The area is covered by rocks (gabbro-norites, diorites, amphibolites, local granites and, mostly in Duber-Besham section, sediments. Prasanitic schists are shown to form a prominent zone near Sazin. These are now considered as a major shear in the gabbro-norites of the Chilas complex.
Key Words: Reconnaissance, Chilas, Besham, Kohistan, Indus valley.

D/168. Desio, A., 1974b. Karakorum Mountains. In: Spencer, A.M. (ed.), Mesozoic-Cenozoic Orogenic Belt. Geological Society of London, Special Publication 4, 255-266.

Regional framework of the geology and tectonics of the Karakoram Range are described. A useful regional map of lithotectonic blocks of the Central Asia is also given.
Key Words: Orogenic belts, Mesozoic, Cenozoic, Karakoram

D/169. Desio, A., 1974c. On the geology of southern slope of Masherbrum peak and the upper Hushe valley (Karakorum, Central Asia). Rendiconti Academia Nazionale dei Lincei, series 8, 79-100.

Key Words: Mountain peaks, Masherbrum, Karakoram.

D/170. Desio, A., 1975a. Some geological notes and problems on the Chitral valley (NW Pakistan). Rendiconti Academia Nazionale dei Lincei, Sereies 8, 58, 611-617.

Key Words: Geology, Chitral valley.

D/171. Desio, A., 1975b. Una visita al Ghiacciaio Kuthiah nel Karakorum Centrale (Pakistan). Bollettino della Societa Geologica Italiana. 22, (1974), 39-44.

Key Words: Glaciers, Kuthiah, Karakoram.

D/172. Desio, A., 1976a. Introductory Report on the geotectonics of the Kashmir Himalaya – Karakorum – Hind Kush – Pamir orogenic belts. Accademi Nazionale dei Lincei: International Colloquium on the Geotectonics of the Kashmire Himalaya – Karakorum – Hind Kush – Pamir Orogenic Belts, 1974, Roma, 9-13.

Key Words: Geotectonic, Kashmir, Himalaya, Karakorum, Hindukush, Pamir

D/173. Desio, A., 1976b. Some geotectonic problems of the Kashmir-Himalaya-Karakorum-Hindukush and Pamir area. Atti dei Convegni Lincei: International Colloqvium on the Geotectonics of the Kashmire Himalaya – Karakorum – Hind Kush – Pamir Orogenic Belts, 1974, 115-129.

Key Words: Geotectonic, Kashmir, Himalaya, Karakorum, Hindukush, Pamir

D/174. Desio, A., 1977a. Correlation entre les structures des chaines du Nord Est de l'Afghanistan et du Nord-Ouest du Pakistan. Societe Geologique France, Memoirs 8, 179-188.

In order to proceed to the structural correlations between the mountain chains of NE Afghanistan and chains of the NW Pakistan, both the regions have been divided in tectonic zones, on the ground of their stratigraphic compos and of their tectonic structure which express their geological evolution. The tectonic zones have been grouped in relation to the age in which the last orogenic phase (that is to say Hercy Cimmerian and Alpine), happened. Each zone has been separated from the surrounding zones by some of the deepest and persistent faults.

The NE Afghanistan has been divided in two folding areas the Hercynian one west and south-westward, and the merian one east and south-eastward. In the first area three tectonic zones have been distinguished. From the west to the they are : a) Surkhab zone ; b) Fayzabad zone ; c) western Hindu Kush zone.

The mean fault of the Badakhshan and that of Herat (or Hari Rud) delimitate the Hercynian zones from the Cimmones. The last ones are represented by : a) Safed Khers zone ; b) South eastern Badakhshan zone ; c) Nuristan zone. All these are to be correlated with the tectonic zones of Pamir; except the western Hindu Kush.

In north-western Pakistan two tectonic zones have been distinguished: a) Eastern Hindu Kush zone; b) Karakorum: Southward there is the Kohistan zone. The former is included in the early Alpine folding, the latter in the late Alpine folding former represents the north-eastern part of the Nuristan zone, the latter doesn't find any correlation in Afghanistan, as its metral faults close before reaching the frontier. The Kohistan zone is to be related with the tectonic zones of the central south Afghanistan and then it's out of the examined area.

The present structure of the region is the consequence of the tectonic splitting up during the geological time reach and reelaborated in consequence of the collision of the Indian and the Arabic plates with the Euroasiatic plate.
Key Words: Structure, tectonics, Afghanistan, Pakistan.

D/175. Desio, A., 1977b. The works of the Italians in the scientific exploration of Karakorum (Central Asia). Accademia Nazionale dei Lincei, No. 374, Quderno, 231, 1-22 and the Himalayan Journal 36, 126-136.

Key Words: Scientific exploration, Karakoram.

D/176. Desio, A., 1977c. The occurrence of blueschists between the Middle Indus and the Swat valleys as an evidence of subduction. Rendiconti Accademia Nazionale dei Lincei, series 8, 62, 653-661.

Blueschist occurrence in Shangla area of Swat was the first of its type reported in the Indus suture zone. Dated at mid-Cretaceous, the blue amphibole occurs in a number of lithologies. Its occurrence is attributed to northward subduction of the Indian plate.
Key words: Blueshists, High-pressure metamorphism, Indus Suture, Swat.

D/177. Desio, A., 1978. On the geology of the Deosai Plateau (Kashmir). Memorie dell'Academia Nazionale dei Lincei, Series 8, Volume 62, 15, 1-19.

Desio visited the Deosai area and studied the rocks previously described in some detail, (Wadia 1937). He provided additional details on the geology and structure of the area (also known as Little Tibet) and petrography of the rocks which show low grade alteration. He also mentioned the occurrence of andesite among the volcanics. Desio presented a geological map covering the area between Skardu, Astor, Kalapani, Dras, Kargil, and Parkutta, however, the central part of this area was not covered. He described a great number of rock types including sediments of various ages including Precambrian, cal-alkaline plutonic rocks, gneisses and schists and so on.
Key Words: Geology, maps, Deosai Plateau, Kashmir.

D/178. Desio, A., 1979. Geological evolution of the Karakorum. In: Farah, A. & DeJong, K.A. (eds.)., Geodynamics of Pakistan. Geological Survey of Pakistan, Quetta, 111-124.

The Karakoram mountain range is divided into five zones. The central zone, a granitic batholith, is the core of an anticlinorium. The northern zone contains mostly unmetamorphosed rocks of the Paleocene to Late Cretaceous age. The southern zone is mainly composed of metamorphic Paleozoic (or Precambrian) to Upper Tertiary formations. Farther to the south are two other zones, one to the east (Ladak-Deosain zone), and the other to the west (Kohistan zone) of the Nanga Parbat Haramosh Massif. This massif is oriented perpendicular to the main Karakorum trend and penetrated deeply into the southern zones. It is interpreted as the most prominent spur of the old Indian continent.
The tectonic evolution of the Karakorum is related to the Indian subcontinent's northward displacement and collision with Eurasia along the Upper Indus Suture Line and, to the west, the Kohistan line. The maon tectonic phase began in Cretaceous and continued through the Tertiary; the upheaval of the mountain belt began in the late Neogene and is still occurring.
Key Words: Orogeny, geology, Karakoram.

D/179. Desio, A., 1980. The age of the blueschists and the Indus-Kohistan suture line, NW Pakistan. Rendiconti Accademia Nazionale dei Lincei, series 8, 75-79.

White mica is dated by K/Ar method at 80 Ma.
Key words: Blueschists, radiometric dating, Indus suture, Swat.

D/180. Desio, A., 1982a. Scienziati italiani nel Karakorum e nell'Hindu Kush (Asia Centrale). Annuario del C.A.I., 1981, 9-13.

Key words: Karakoram, Hindu Kush.

D/181. Desio, A., 1982b. Geological notes on the K^2 (Chogo-ri Massif) in the Karakorum. The Himalayan Journal 38 (1980-1981), 142-145.

Key words: Geology, K2, Karakoram.

D/182. Desio, A., 1982c. A geological section across Himalaya and its relation with the seismic profile Punjab-Pamir. The Pamir Himalaya Deep Structure of the Earth's Crust, 144-152. Moscow (in Russian).

Key words: Seismic profile, geologic cross-section, Pamir-Punjab.

D/183. Desio, A., 1983a. A geological section across the Karakorum and Kashmir Himalayas and its relationship to the seismic profile Punjab-Pamirs. Bollettino di Geofisica Teorica ed Applicata (Pamir-Himalaya Volume) 25, 339-349.

Key Words: Seismic profile, geological cross-section, Punjab, Pamir, Karakoram, Himalaya.

D/184. Desio, A., 1983b. Geological notes on the Falchan Kangri (Broad Peak,8047 m) in Karakorum. Himalayan Journal 39 (1980-1981), 129-135.

Key words: Geology, broad peak, Karakoram.

D/185. Desio, A., 1984a. L'esplorozione del ghiacciano Abruzzi e l'ascensione all "Probable Saddle' di Martin Convay. Dal Polo al K^2, sulle orme dell Duca degli Abruzzi, 1899-1954, 67-72. Museo della Montagna, Torino.

Key words: Karakoram.

D/186. Desio, A., 1984b. Gli italiani e l'esplorazione scientifica del Karakorum e dell' Hindu Kush. Ibid 97-104.

Key words: Italian Scientific Exploration, Karakorum, Hindukush.

D/187. Desio, A., 1984c. Quattro visioni del K2 nel Karakorum. Dai miei diari di viaggio. Notiziario della Bmca Popolare di Sondrio, 34, 1-12.

Key words: K2, Karakoram, Desio's travelogue.

D/188. Desio, A., 1984d. Notes on the Gasherbrum ridge in the Karakorum Range. Himalayan Journal 40, 143-149.

Gasherbrum is one of the most prominent ridge of the central Karakoram and lies in the K2 region. Desi's contribution is important about the ridge which has been investigated by only few. The rocks are metasedimentary with granitic intrusions.
Key words: Geology, Gasherbrum, Karakoram.

D/189. Desio, A., 1988a. Italian Expedition to Tibet and Pakistan to conduct further observations on the altitude of Mount Everest and K^2. The American Alpine Journal 30, 180-183.

Key words: Altitude, K2, Everest.

D/190. Desio, A., 1988b. Which is the highest peak in the World? The Explorer Journal 66, 90-95, New York, and Himalayan Journal 45, 17-23.

Key words: K2, Everest.

D/191. Desio, A., 1989a. Risultati dell misure altimetriche dell' Everest e del K2 effectuate dell spedizione italiana Ev-K2 CNR. Rediconti Accademia Nazionale Lincei, Series 8 (82) 309-312.

Key words: Everest, K2.

D/192. Desio, A., 1989b. Which is the highest Mountain in the World? Report of the Expedition Ev-K2-CNR to the Mt. Everest and K2 1987. Atti del'Accademia Nazionale Lincei, Memoirie, Series 8(17), Sez. 1a, 174-194.

Key Words: Italian expedition, Everest.

D/193. Desio A., 1991. Geographical features of the Karakorum. Italian Expidition to the Karakorum (K2) and Hindu Kush (A. Desio leader). I-Geography, volume 1, 1-73, ISMEO, Milano (Scientific Reports 1-Geography).

This article is a detailed account of the geography of the Karakoram and contains 59 illustrations. These and the text cover the origin of the names of the mountain, its orography, drainage, subdivision into mountain ranges, the boundaries of the Karakoram and the location of the range in regional tectonic framework. The author also gives a useful summary of the scientific activity of Italians in the exploration of the Karakorum before the Second World War (10 pages), followed by a brief history of Desio's expeditions to the Karakoram and eastern Hindu Kush (5 pages), and topographic maps surveyed by Italian expeditions in the Karakoram (14 pages). These last pages also show excellent maps of some major glaciers. The account is followed by an extensive, but not complete, list of publications (302) by the Italian expeditions to Karakoram, and NE Hindukush, and a list of the five major maps produced earlier.
Key Words: Italian expedition, geography, bibliography, Karakoram, Hindukush.

D/194. Desio, A. (ed.), 1991. Italian Expeditions to the Karakoram (K2) and Hindukush. IsMEO, Milano (Scientific Reports 1-Geography).

Of these volumes, the ones related to Earth Sciences specifically are listed under Italian Expeditions to the Karakorum (K2) and Hindu Kush in the appropriate place.
Key Words: Italian expedition, Karakoram, Hindukush.

D/195. Desio, A., Biggioggero, B., Casnedi, R., et al., 1976. The 1975 geological-geophysical expeditions in the Kashmir Himalayas and in the Western Karakorum (Pakistan): geological research. Atti Societe italiana Sciences natural 117, 303-309.

Key words: Geology, Italian Expedition, Kashmir, Karakoram.

D/196. Desio, A., Casnedi, R., Forcella, F., Nicoletti, M. & Petrucciani, C., 1978. Absolute age of some granitoid rocks between Hindu Raj and Gilgit River (Western Karakorum). Rendiconti Academia Nazionale dei Lincei, Ser. 8(64), 204-210.

Key words: Geochronology, granites, Hindu Raj, Gilgit, Karakoram.

D/197. Desio, A. & Cita, M.B., 1955. Nuovi vi trova menti di calcari fossiliferi del Paleozoico super ore nel bacino del Baltoro (Himalaya-Karakorum). Rendiconti dell' Accademia Nazionale dei Lincei, Series 8 (17/18), 587-598.

Key Words: Fossiliferous limestone, Paleozoic, Baltoro.

D/198. Desio, A. & Giobbi Mancini, E., 1974. On the geology of the southern slope of the Masherbroom Peak and the upper Hushe valley (Karakorum, Central Asia). Memoire Accademia Nazionale de Lincei, Series 8 (12), 79-100.

Key Words: Geology, Masherbrum, Karakoram.

D/199. Desio, A. & Longinelli, A., 1961, Sull' eta dei graniti del Baltoro (Karakorum-Himalaya), Rendiconti Academia Nazionale dei Lincei, Ser. 8 (30), 437-448.

Key Words: Granites, glaciers, Baltoro, Karakoram.

D/200. Desio, A. & Martina, E., 1972. Geology of the upper Hunza valley, Karakorum, West Pakistan. Bulletino della Societa Geologica Italiana 91, 283-314.

The Paleozoic and Mesozoic sedimentary rocks of the area have been described together with some description of the Late Cretaceous granite intrusions. The authors produced the first geological map of the upper Hunza valley, and the sedimentary formations were shown as following:
Misgar Slate
Kilik Formation
Gircha Formation
Passu Slate
Gujhal dolomite
Shanoz conglomerate.
This paper describes the geology of the region explored during the summer of 1962 by the DESIO's Upper Hunza expedition. The northern boundary is represented by the Pakistan-China border; the southern boundary by the axial batholith of the Karakorum range. The igneous rocks have been divided as follows: Giraf Syenite (Eocene), Granodiorite of the axial batholith (Pliocene), with pegmatite and aplite stocks and dykes (Late Pliocene); Syenite porphyry and amphibolite dykes crossing the Misgar Slates, the Gircha Formation and the Gujhal Dolomite. The metamorphic rocks have been divided in the Dumordo Formation and the migmatic plagioclase-gneiss of unknown age outcropping to the south of the batholith.
The sedimentary formations of Palaeozoic and Triassic age have been sub divided as follows: Misgar Slate, probably the oldest, Kilik formation of uncertain stratigraphic and tectonic position, Gircha Formation with Permian megafossils and microfossils, Pasu Slates of uncertain stratigraphical position and Gujhal Dolomite, Triassic and possibly Lower Jurassic.
The tectonic structure of this region is characterised by overthrusted, folded and faulted blocks with the fault-planes generally dipping south on the northern side of the Karakorum range (Batura ridge), and in the opposite direction on its southern side. The strike of the tectonic units is north-west that is parallel to the axis of the axial batholith.
The stratigraphy of the Upper Hunza valley is similar to the stratigraphy of the Shaksgam valley. The two valleys are located to the north of the Karakorum axial batholith. In the Upper Hunza valley and in some tributary valleys, remnants (till) of two, and probably three, glaciations associated with fluvio-glacial deposits are present.

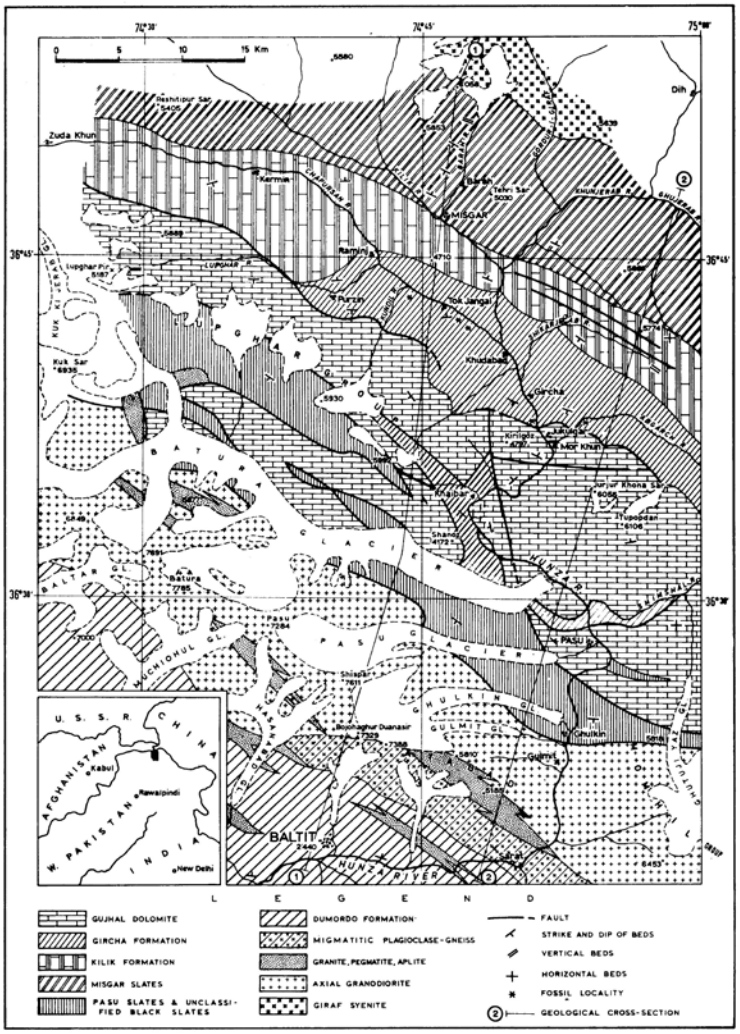

fig. 1 — Geologic sketch-map of the upper Hunza valley (the area to SW of Batura glacier according to SCHNEIDER, 1957).

Key words: Geology, stratigraphy, granites, Hunza valley.

D/201. Desio, A., Martina, E. & Galimberti, R., 1963. Notizie geologische preliminari sull' Alta valle di Hunza (Karakorum-Himalaya). Rendiconti Accademia Lincei, Series 8 (34), 115-117.

Consult the preceding account.
Key Words: Geology, Hunza, Karakoram.

D/202. Desio, A., Martina, E., Spadea, P. & Notarpietro, A., 1985. Geology of the Chogo Lungma-Biafo-Hispar area, Karakorum (NW Pakistan). Memoire Accadmia Natiozale dei Lincei, Series 8, 18(1), 1-53.

Key Words: Geology, glaciers, Chogo Lungma, Biafo, Hispar, Karakoram.

D/203. Desio, A. & Marussi, A., 1960. On the geotectonics of the granites in the Karakorum and Hindu Kush Ranges (Central Asia), International Geological Congress, Reports of 21st Session, Part 2, Proceeding 2, 156-162.

Key Words: Geotectonics, granites, Karakoram, Hindukush.

D/204. Desio, A., Marussi, A. & Caputo, M., 1961. Glaciological research of the Italian Karakorum expedition 1953-55, International Association Hydrological Sc., Snow and Ice Commission, Publication 54, 224-232.

Key Words: Glaciology, Italian expedition.

D/205. Desio, A. & Orombelli, G., 1971. Notizie preliminary sulla presenze di un grande ghiacciaio valliro nella media valle dell' Indo (Pakistan) durante I Pleistocene. Accademia Nazionale Dei Lincei 51(8), 387-392.

In the summer 1971 during the exploration of the middle Indus valley between Chilas and Besham Qila, three huge end moraines of the Pleistocene Indus glacier were discovered. The uppermost deposit blocks the bottom of the valley near Gunar (1220 m a.s.l.), the second near Dudishal (840 m), and the third near Shatial (800 m). The first is more recent than the other two. Some more recent end moraines were discovered in the lower Gilgit valley, near Dak Chanki and upstream of Gilgit town. The above end moraines are to be referred to three different Pleistocene glaciations for their different location and state of preservation.
Key Words: Glaciers, Pleistocene, Indus valley.

D/206. Desio, A. & Orombelli, G., 1983. The "Punjab Erratics" and the maximum extent of the glaciers in the Middle Indus Valley (Pakistan) during the Pleistocene. Memorie Accademia Nazionale de Lincei, Series 8(17), 135-180.

Key Words: Punjab Erratics, Glaciers, Pleistocene, Indus valley.

D/207. Desio, A., Petrucco, F. & Lombardi, F., 1991. Italian expeditions to the Karakorum (K2) and Hindu Kush, 1-Geography, 1, Milano, 158p.

Key Words: Italian Expedition, Karakoram, Hindukush.

D/208. Desio, A., Premoli S.I. & Rossi Ronchetti, C., 1977. On the Cretaceous outcrop in the Chumarkhan and Laspur valleys, Gilgit-Chitral, northwest Pakistan. Riviews Italian Paleontology 83, 561-569.

Key Words: Palaeontology, Cretaceous, Gilgit, Chitral.

D/209. Desio, A. & Savoia Aosta, A., 1936. La Spedizione Geografica Italiana net Karakoram. Arti Grafiche Bertarelli, Milano.

Key Words: Italian Expedition, geography, Karakoram.

D/210. Desio, A. & Shams, F.A., 1977. The occurrence of blueschists between the Middle Indus and Swat Valley as an evidence of subduction (N. Pakistan). Accadmia Nazionale dei Lincei, Series 8, 62, 1-9.

Consult the following account.
Key Words: Subduction, Indus suture, blueschists, Indus, Swat.

D/211. Desio, A. & Shams, F.A., 1980. The age of blueschists and the Indus-Kohistan suture line, NW Pakistan. Accadmia Nazionale dei Lincei, Series 8, 68, 74-79.

Outcrops of blueschists occur in the Indus suture mélange at Shangla, Swat. Petrography and tectonic significance of the rocks is described. Blueschist metamorphism has an age of 85 Ma (K-Ar muscovite) and is related to subduction.
Key Words: Indus suture, blueschists, Swat.

D/212. Desio A., Tongiorgi, E. & Ferrara G., 1964. On the geological age of some granites of the Karakorum, Hindu Kush and Badakshan (Central Asia). Proc. 22nd Int. Geol. Congress, 11, 479-496.

The authors report Rb-Sr dates on 22 samples of granitic rocks of the region. Sample numbers and dates are plotted. The cores of the Karakorum and Hindu Kush ranges are mostly composed of granite and granodiorite, which form large arches around the vertex of Himalayan syntaxis. Smaller granitic bodies crop out laterally from the main arches.
Previously, the age of the granitic rocks was known only locally by means of stratigraphic methods. The authors present new data about the age of the granites obtained by the Rb/Sr method. They found granites of seven different ages belonging to the Lower Triassic (Hercynaian); Upper Triassic and Upper Jurassic (Cimmerian); and Upper Cretaceous, Oligocene, Miocene and Pliocene (Alpine).
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Key words: Geochronology, granites, Karakoram, HinduKush.

D/213. Desio, A. & Zanettin, B., 1956a. Sul la constituzione geologica dela catena del Karakorum Occidentale (Himalaya), International Geological Congress 20th Session, Mexico, 15, 1-11.

Key Words: Orogeny, Karakoram, Himalaya.

D/214. Desio, A. & Zanettin, B., 1957a. Sul la constitution geologique de K-2 (8611 m) dan Ia chiane du Karakorum (Himalaya). Bulletin de Ia Societe Geologique de France, Ser. 6e, tome 6, 829-837.

Key Words: Geology, K2, Karakoram.

D/215. Desio, A. & Zanettin, B., 1957b. Notizie geologico-petrografiche preliminari sul baciono del ghiaccaio Baltoro, La Ricerca Scientifica, anno, 27(3), 657-673.

Key Words: Glaciers, geology, petrography, Baltoro, Karakoram.

D/216. Desio, A. & Zanettin, B., 1970. Geology of the Baltoro Basin. Italian Expeditions to the Karakorum (K2) and Hindu Kush (leader A. Desio). Scientific Report III, Volume 2, 35-148. Brill, Leiden.

This paper gives many Rb-Sr and K-Ar dates for the Karakoram granitoids. These include:
38 Ma on granite pebble in Himis (Ladakh) conglomerate; 30 Ma Rb-Sr whole rock age for biotite-muscovite paragneiss west of Younghusband glacier near contact with Baltoro granite; 12.5 Ma whole rock on amphibole-sphene-epidote gneiss from moraign of Younghusband glacier coming from southern wall of Mustagh tower.
Key words: Baltoro Basin, radiometric ages, Central Karakoram.

D/217. De Terra, H., 1932. Geologische Forschungen im Westliche Kun–Lun und Karakorum–Himalaya. Wiss Ergebnisse Trinkler' Schen Zentralasien Exped., 11 D. Reimer, Berlin.

Key Words: Himalaya, Karakoram, Kun Lun.

D/218. De Terra, H., 1932–1935. Geological studies in the northeast Himalaya between the Kashmir and Indus valleys. North India Exped., Connecticut Acad. Arts and Science, Yale University Memoir, 8(2), 17–76.

Key Words: Geology, Kashmir, maps, Himalaya.

D/219. De Terra, H., 1934. Neuere Forschungsergebnisse im Himalaya-Gebiet, Central bl. fur Mi, Abt.B, 7, 317-318.

Key Words: Himalaya.

D/220. De Terra, H., 1936. Himalaya and Alpine orogenesis. 16th International Geological Congress U.S.A. Rep. 1(2), 859–971.

Key Words: Alpine orogenesis, Himalaya.

D/221. De Terra, H., 1938. Correlation between glacial and fluvial cycles during the great Ice Age. Geological Society of America Bulletin, 12, p. 49.

Key Words: Glacial, fluvial, ice age.

D/222. De Terra, H. & De Chardin, P.T., 1936. Observations on the upper Siwalik Formations and later Pleistocene deposits in India, Proceedings American Philosophical Society, 76, 791-822.

The authors detailed the relationship of the Siwaliks to later Pleistocene sediments deposited in from of the Himalayan orogeny. They consider the ‘Boulder Conglomerate stage’ as the uppermost unit of the Siwalik group. They place this unit in the Middle Pleistocene and associate it with the second glaciation of Kashmir. The Punjab erratics are closely correlated with the deposits of the Boulder Conglomerate stage. They are thought to have been jointly carried with the coarse deposits of the conglomerate during catastrophic floods due to the breakthrough of lakes dammed by the ice in the Upper Indus basin. This is likely to have happened during the withdrawal period of second glaciation when the erratics may have been moved along the Indus at a time when the river running at the foot of mountains followed the course of the present Haro river rather than at its present course. The authors deny the presence of a large lake in the northern Punjab at the time when erratics were scattered.

According to these authors, the ‘Boulder Conglomerate stage’ is followed with disconformity by the series ‘Potwar silt’ formed of sand and gravels at the base (known as ‘Potwar gravel’) and of silt for approximately 100 mIt is considered to be a deposit of the loess-type having been reworked by runoff and stream flow waters. The ‘Potwar loessic silt’ is attributed to the Late Pleistocene and correlated with the 3rd glaciation of Kashmir. [Authors' Comments: This description is a nearly verbatim copy of the account given in Desio and Orombelli, 1983, p. 141-142].
Key words: Glaciation, glaciers, Karakoram, Himalaya, Punjab erratics

D/223. De Terra, H. & Hutchinson, G.E., 1936. Data on postglacial climatic changes in northwest India. Current Sciences 5, 5-10.

Key Words: Post-glacial climate change, NW India.

D/224. De Terra, H. & Tongiorgi, E., 1964. Notizie preliminari sull eta geological di aclune rocce Granitioidi del Karaorum Hindu Kush e Badakhshan (Asia Centrale). Rend. Accad. Lincei, 35, 776–773.

This paper gives preliminary geological descriptions of granitic rocks from the ranges of Karakoram, Hindukush and Bakhshan in Afghanistan.
Key Words: Granites, Karakoram, Hindukush, Central Asia.

D/225. De Terra, H., Tongiorgi, E. & Ferrara, G., 1964. On the geological age of some granites of the Karakorum, HinduKush, and Badakhshan, Central Asia. 22nd International Geological Congress New Delhi, Proceedings 11, 479–496.

Key Words: Chronology, granites, Karakoram, Hindukush, Central Asia.

D/226. De Verneuil, E., 1866. Note on fossils collected in Kashmir, etc., by M.A.V. Verchere, Asiatic Society of Bengal Journal, 36(2), 201-229.

Key Words: Fossils, Kashmir.

D/227. Dewey, J.F., Cande, S. & Pitman, W.C., 1989. Tectonic evolution of the India/Eurasia collision zone. Eclogae Geologicae Helvetiae 82, 717-734.

Key Words: Tectonics, India-Eurasia, collision, Island arc.

D/228. Dichter, D., 1968. The physical evolution of the North West Frontier Region of West Pakistan. Pakistan Geographical Review 23, 78-91.

This contribution deals with the physical geography/geomorphology of the province. The mountain regions, river valleys, intermountain basins, and plains are described.
Key Words: Geography, geomorphology, NWFP.

D/229. Dichter, D. & Popkin, N., 1967. The North West Frontier Province of West Pakistan. A study of regional geography. Clarendon Press, Oxford, 231p.

Key Words: Geography, NWFP.

D/230. Dickins, J.M., 1952. Upper Paleozoic fossils from the North West portion of the Gilgit Agency, Pakistan, Commonwealth. Australia Bur. Mm. Rec. Geol. Geophys., Rec. 1952, 42p.

Key Words: Fossils, Paleozoic, Gilgit.

D/231. Diemberger, K., 1968. Ein Apfel auf dem Tirich Mir (Reisebericht der Osterr. Hindukusch Expedition 1967). Jahrbuch der Osterreichischen Alpenverein, Bd. 1968, Verlag Wagener, Innsbruck, 143–157.

Key Words: Hindukush expedition, Tirichmir, Chitral.

D/232. Diener, C., 1912. The Trias of the Himalaya. Geological Survey of India, Memoir. 36(3), 202-360.

Key Words: Himalaya, Triassic, mapping.

D/233. Di Florio, M.R., Faccenna, C., Lorenzoni, S. & Zanettin Lorenzoni, E., 1992. Lithological analysis of materials used in the buildings of the sacred area of Panr I (Swat Valley—N.W.F.P. Pakistan) and their origins. In: Faccenna, D. (ed.), “Panr I (Swat Pakistan)”, IsMEO (Instituto Medio Estremo Oriente) Report and Memories, Roma, 357p.

Key Words: Lithology, sacred area, Swat.

D/234. Di Florio, M.R., Lorenzoni, S. & Zanettin Lorenzoni, E., 1991. Geo-archaeological study of Gandhara remains in the Swat valley (NW Pakistan). Abstracts, International Geological Congress, Kyoto, 2, p.388.

The Swat valley has been a cradle of the Gandhara civilization. There are many ruins, statues and artifects, some of which are preserved in the Museum of Archeology and some in Butkara near Saidu Sharif. These have been the subject of long studies by Facenna and his colleagues. Many of the remains comprise low-grade metasediments (graphitic schists, greenschists, dolomite-talc rocks, serpentinite, granitic rocks, etc. These have been extracted from the nearby terrain belonging to the Indian plate and the Indus suture mélange north of Mingora.
Key Words: Geoarchaeology, Gandhara, Swat.

D/235. Di Florio, M.R., Lorenzoni, S. & Zanettin Lorenzoni, E., 1991. Geo-archaeological study of Gandhara remains in the Swat valley (NW Pakistan). In: “Archaeological Stone” The British Museum, London.

Please consult the preceding account for further details.
Key Words: Geoarchaeology, Gandhara, Swat.

D/236. Di Florio, M.R., Lorenzoni, S. & Zanettin Lorenzoni, E., 1997. Relationships between ancient settlements and Geology, lithology, geomorphology in the Lower Swat valley (NWFP, Pakistan). In: Sinha, A.K., Sassi, F.P. & Papanikolaou, D. (eds.), Geodynamic Domains in Alpine-Himalayan Tethys. Oxford & IBH Publishing Co., New Delhi, 209-220.

Key Words: Geology, geomorphology, lithology, Swat.

D/237. Di Florio, M.R., Lorenzoni, S., Olivieri, L. & Zanettin Lorenzoni, E., 1993. Evidence of ancient stone quarrying in Lower Swat, N.W.F.P., Pakistan. A geo-archaeological study. Science and Technology for Cultural Heritage 2, 63-74.

Traces of ancient quarries are widespread in Lower Swat. Two type of quarry work were found: a) scattered excavations in the zone surrounding Buddhist sacred areas, which provided rocks (phyllites, calc-schists, gneisses) for common building use; b) intensive excavations in the areas with exposures of prized rocks such as soapstone, chlorite-schists, and talc schists, which were used for the facing of walls and for sculptures and decorations. In both types of quarry, blocks and discs were detached directly from the outcrop by chiseling and levering. A quarry village (Swegalai) was found in the main quarry area.
In addition to quarries, traces of excavation such as tanks for working «stucco» (a kind of plaster), small outcrops possibly for milling materials, and cooling instruments and cavities for preserving food were found. The map of the Indus suture is also given.
Key Words: Geoarchaeology, Indus suture, Swat.

D/238. Dilles, J.H., Snee, L.W. & Laurs, B.M., 1994. Geology, Ar-Ar age, and stable isotope geochemistry of suture related emerald mineralization, Swat, Pakistan Himalayas. Geological Society of America, Programs with Abstracts.

Key Words: Chronology, isotopes, geochemistry, emerald, Swat.

D/239. Din, A., Rassol, G. & Rana, N.A., 1963. Purification of commercially exploited glass sands of West Pakistan. Pakistan Journal of Scientific and Industrial Research 15, p.20.

Key Words: Sand, optical glass, heavy minerals, Pezu.

D/240. Din, A., Sindhu, S.D. & Faruqi, F.A., 1963. Purification of Dera Pezu sand for making colourless optical glasses. Pakistan Journal of Scientific and Industrial Research 15, 157-162.

Purification studies (grading, washing, floatation and others) of sand have been carried out. The sand initially contained about 0.26% heavy minerals
Key Words: Sand, optical glass, heavy minerals, Pezu.

D/241. Din, F. & Rafiq, M., 1997. Correlation between compressive strength and tensile strength/index strength of some rocks of North-West Frontier Province (Limestone and Granite). Geological Bulletin, University of Peshawar 30, 183-190.

The use of the building stones is increasing day by day and engineering activities are also in progress. Therefore the mechanical properties of building stones such as limestones, marbles, granites etc are required to be investigated to estimate the strength and give recommendations in designing safe structures. The present research deals with the investigation and correlation of compressive, tensile and index strength of granites and limestones from different localities of North-West Frontier Province. The test results are given in table 1-2, which reveal suitability of Shahbaz Garhi micro granite for heavy constructions and in foundations of buildings while Malakand granite in light constructions, crushed stones, floor material and ballast under railway tracks. The strength values of Cherat and Kohat limestones are low, and very much suitable for cement, chemical industry and ballast under roads.
Key Words: Geotechnical, building stones, NWFP.

D/242. Din, F., Rafiq, M. & Mohammad, N., 1993. Strength properties of various building stones of NWFP, Pakistan. Geological Bulletin, University of Peshawar 26, 119-126.

Domestic resources of both dimension and crushed stones used for construction and adequate to fulfil the expected demand indefinitely in N. W. F. P. Various types of building and decorative stones including limestone, marbles, granite, granitic gneisses, slate, quartzite, dolerite, gabbro, serpentinite etc., are found in large amount in NWFP. Geotechnical properties of these rocks including compressive strength and tensile strength show compatible values to the recommended ASTM range for Thana marble, microporphyrites of Shewa Shahbaz Ghari, Marbles of Nowshera and Pir-Sabak, limestones of Kohat, Cherat and Nizampur areas, and granites of Ambela, Utla and lower swat. Higher values for compressive, tensile and shear strength are for slate from Attock and Cherat ranges. Though the shear strength values for most of these rocks are low, they are free of geotechnical defects.
The data is useful not only for those using these rocks as building and foundation stone and crushed and broken material but also for those interested in designing openings in these rocks.
Key Words: Geotechnical, building stones, NWFP.

D/243. Din, F., Rafiq. M. & Mohammad, N., 1995. Triaxial study of granites and limestones from north and south of Peshawar Basin, NWFP, Pakistan. Geological Bulletin, University of Peshawar 28, 15-25.

Determination of uniaxial and triaxial strength of different building stones is important both from practical as well as academic point of views. Triaxial testing is the most appropriate method, which provides identical field conditions. In order to achieve this objective, granite and limestone from four different localities (Malakand granite, Shahbaz Garhi granite, Kohat limestone and Cherat limestone) were selected to carry out triaxial tests.
Four samples of each rock, having length-to-diameter ratio of about two were tested under confining pressure of 0-30 MPa range. The observations made and results obtained are plotted and after drawing Mohr's envelope for each rock shear strength is calculated corresponding to different triaxial confining pressure. The finding of the study are summarized in the form of conclusion and recommendations at the end of the manuscript.
Key Words: Geotechnical, granites, limestones, Peshawar Basin,

D/244. Din, K.S., Shami, M.D. & Dilawari, A.H., 1967. A study of Pakistani micas. Pakistan Journal of Scientific and Industrial Research 19, 146-156.

Key Words: Minerals, mica.

D/245. Din, N., 1997. Petrography, geochemistry and provenance of Kuldana Formation, Kohat basin, Pakistan. Abstracts, 3rd GEOSAS Workshop on Siwaliks of South Asia, Islamabad. Geological Survey of Pakistan, Records 109, 85-89.

The Kohat Basin constitute the westernmost part of the Himalayan foreland basin. It is bounded to the north by Main Boundary Thrust and to the south by Surghar Range Thrust. The Kalabagh Fault and Kurram Fault forms the eastern and western boundaries of the basin respectively. Stratigraphically the Kohat basin consists predominantly of Eocene and younger rocks. The Kuldana Formation is the part of Eocene strata and well-exposed in the whole Kohat basin. It generally consists of about 95% uniform red shale and 5% channel sandstone. The formation is continental and fluvial facies, and has been interpreted as a deposit of poorly developed system of small streams by Wells (1983).
A section of Kuldana Formation, near Bahadurkhel village in central Kohat basin, was measured and sampled. The section is 110 meters thick and consists of red clays with subordinate sandstone and granulestone. Sandstones are brownish red to red on fresh surface while dark red on weathered surface. Sandstones are line to coarse grained, thin to medium bedded and calcareous. In sandstone various sedimentary structures, like cross-beddings, sole marks, graded beddings are present. The formation is devoid of any mega-fossil. The basal contact of the formation with Jatta Gypsum is mostly covered by recent debris while upper contact with Kohat Formation is conformable. The samples from the sandstone beds of the Kuldana Formation was studied in detail.
PETROGRAPHY: The petrography of sandstones of Kuldana Formation reveals that they are immature both mineralogically and texturally. The quartz and lithics are the dominant mineral along with subordinate feldspar. Quartz grains are mainly monocrystalline, however, polycrystalline variety is also present. Quartz grain are generally devoid of inclusions and show non-undulatory extinction. The detrital litliics consists of sedimentary and

volcanic lithics while metamorphic lithics are virtually absent. Sedimentary lithics constitute 80-85 percents of the total lithic fraction and include fragments of limestone, granules, shale and fossil. Volcanic lithics are mainly volcanic glass and altered rock fragments. The feldspar content of Kuldana sandstone is very low. Hematite, limonite and siderite are dominant opaque heavy mineral present. Calcite is the major cementing material. The texture of sandstones is typical of litharenite. The grains show point and concavo-convex contacts. The sandstones are poorly sorted. Grains are mostly subrounded to subangular.
Modal composition of ten sandstone samples of Kuldana Formation was determined by point-counting. The point-counting was done according to Ghazzi-Dickinson point-counting method (Ingersol et al., 1984) to determine the proportion of monocrystalline and polycrystalline quartz types (Q), feldspars (F) and lithics (L). The modal composition of the sandstones is given in Table I. QFL diagram after Folk (1968; Fig. 1) shows that sandstones fall in litharenitee category.
GEOCHEMISTRY: The geochemical analysis of sandstone of the Kuldana Formation for major elements was done by XRF (Table 2). The SiO2/A12O3 and Na2O/K2O ratios plot (after Pettijobn et al. 1985, Fig. 2) shows that sandstones fall in "Sublithicarenite" field. This difference in sandstone classification from the petrographic classification is probably due to slightly high values of A12O3 contributed by clay. The chemical analysis shows that the variation in the proportion of major oxides across the sequence are appropriate to those of modal analysis. The higher content of quartz and carbonates (litliics) with small amount of feldspar in modal composition are compatible to higher quantity of Si02 and CaO, and lesser A12O3, 1(20 and Na2O in chemical composition.
PROVENANCE: The textural and mineralogical immaturity of sandstones suggests a derivation of constituent materials under the conditions of greater mechanical disintegration and comparatively little transportation. The lack of feldspars and metamorphic lithics, and abundance of sedimentary and volcanic rock fragments imply the absence of any large area of eroding metamorphic and intrusive rocks. The presence of volcanic glass and rock fragments, and properties of quartz grains suggests a possible volcanic source. The sedimentary rock fragments that can be identified easily with the rocks of the Kohat basin section such as fragments of granules, limestone, fossil, and soft pelitic rocks, demonstrate that some materials were being supplied by local source area within the basin. In short, the petrographic studies suggests a volcano-sedimentary provenance of the Kuldana Formation.
The point-counting data was plotted on QFL provenance discrimination diagram after Dickinson (1985, Fig. 3). The data plots in the recycled orogen field of the diagram. It means that constituent material of sandstones have been derived from one of the following setting: Subduction complex; Collision orogen; Foreland uplifts (Dickinson, 1985). The high lithics percentage, high quartz ratio to feldspar, intermediate quartz content and low Lvi ratio indicate a collision orogen provenance (Dickinson, 1985). Thus, the modal composition of the Kuldana Formation indicates that constituent materials were derived from collision tectonic setting. The major element geochemical data when plotted on the provenance discrimination diagram after Bhatia (1983, Fig. 4) also indicate a similar tectonic regime. The paleocurrent analysis data of Kuldana Formation in whole Kohat basin reported by Wells (1983) demonstrates that depositing streams flowed into the basin from west and north. The flow from the edges of the former continental shelf of Indian plate suggests that orogeny on the continental slope had reversed the paleoslope. All these evidences from the petrography, modal composition, geochemistry and paleocurrent analysis suggests that detritus of Kuldana Formation has been derived from the collisional orogenic setting. It means that by the time of deposition of Kuldana Formation the India had collided against Eurasia or at least with Afghan microplate.
Key Words: Petrography, geochemistry, provenance, Kuldana Formation, Kohat basin.

D/246. Din, N., Abbasi, I.A. & Khan, M.A., 1998. Provenance of early-middle Eocene fluviatile Kuldana Formation in Kohat Basin, northern Pakistan. In: Ghaznavi, M.I., Raza, S.M. & Hasan, M.T. (eds.), Siwaliks of south Asia. Geological Survey of Pakistan, Islamabad, 93-97.

Key Words: Provenance, Kuldana Formation, Eocene, Kohat basin.

D/247. Din, S.M.U., 1990-92. Geological mapping of Nauseri-Muzaffarabad-Garhi Habibullah area and evalution of landslide hazards on western limb of Hazara-Kashmir Syntaxis. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 52p.

A large scale (1:15,000) geo1ogical map of Nauseri-Muzaffarabad-Ghari Habibullah area was prepared and all the rocks type in the area from Pre-Cambrian to Recent were thoroughly studied and investigated. The northwestern part of Muzaffarabad and western limb of Hazara-Kashmir syntaxis is the area of high landslide hazards. Steep slopes

silty, sandy and clayey soils, heavy rainfalls, water seepages and under cutting of the river all contribute to the landsliding in the region. The instabi1ity of the area has been further increased by road widening and effect of Main Boundary Thrust (MBT), resulting in the form of major landslides such as, slumping, earthflows, rockfalls, sinkholes and combination of these. The active Lohar Gali landslide is investigated in detail because of its large size and proximity to roadways. Soil samples were collected to evaluate engineering properties of material involved in these failures. The investigated area is a limb of Hazara Kashmir Syntaxis of folded and faulted, low grade metamorphic rocks, which have been further deformed by the important Muzaffarabad fault and regionally significant Main Boundary Thrust (MBT).
Key Words: Mapping, landslide hazards, Hazara Kashmir syntaxis.

D/248. Di Pietro, J.A., 1990. Stratigraphy, structure, and metamorphism near Saidu Sharif, Lower Swat, Pakistan. Ph.D. thesis, Oregon State University, Corvallis, 182p.

Key Words: Metamorphism, stratigraphy, structure, Swat.

D/249. Di Petro, J.A., 1991. Metamorphic pressure-temperature conditions of Indian Plate rocks south of the Main Mantle Thrust, Lower Swat, Pakistan. Tectonics 10, 742-757.

The Lower Swat rock sequence, in northern Pakistan, is composed of greenschist and amphibolite facies Indian plate rocks that crop out in a dome directly south of the Main Mantle thrust zone and Kohistan arc terrane. The metamorphism is Eocene to Oligocene in age and records the collision of the Indian plate with the Kohistan arc. This paper presents mineral assemblage, mineral composition and garnet zoning data on the Lower Swat rock sequence in order to estimate the pressure-temperature conditions of metamorphism and to infer a possible pressure-temperature-time path. The stratigraphic sequence consists of Precambrian to Cambrian (?) Manglaur formation unconformably overlain by late Paleozoic to early Mesozoic Alpurai group. The Alpurai group is further subdivided into the Marghazar, Kashala, Saidu and Nikanai Ghar formations. The Manglaur formation, in the core of the dome, is at kyanite grade. Metamorphic grade decreases in the overlying Alpurai group where a garnet "isograd" is mapped in calcareous schist of the Kashala formation. Mineral composition geothermometers and geobarometers indicate final metamorphic equilibrium conditions of about 600°–700°C and 9–11 kbar in the Manglaur and Marghazar formations. These conditions are associated with a phase of static recrystallization which postdates the main phases of deformation. Correlation of the structural-tectonic history with the pressure-temperature estimates, and with the garnet zoning analysis, suggests that in the Eocene the Lower Swat rock sequence was subducted to a depth of 35 to 45 km beneath the MMT suture melange. Subduction was followed immediately by exhumation. The initiation of exhumation is believed to have been triggered by a change from subduction to strike slip motion in the MMT, thereby allowing the relatively buoyant Lower Swat crust to rise. The entire metamorphic-deformational cycle lasted from 7 to 16 m.y., ending in the late Eocene about 38 Ma when the rocks cooled through the argon blocking temperature in hornblende ($\approx$ 550°C).
Key Words: Metamorphism, MMT, Swat.

D/250. Di Pietro, J.A. & Ahmad, I., 1995. Tectonic setting of the Ahingaro serpentinite zone within the Kohistan arc complex, Swat, Pakistan. Geological Bulletin, University of Peshawar 28, 27-29.

In this report we discuss the tectonic significance of a large serpentinite zone that is present within the Kohistan arc complex approximately 10 km north of the Indus suture zone. We have named this the Ahingaro sepentinite zone for excellent exposures at Ahingaro Banda Kandao located along the road between Tutan Banda and Kitiarai. The serpentinite zone was first reported by Rehman & Zeb (1970) who suggested that it was tectonically emplaced within the Kohistan arc complex.
Key Words: Tectonics, ultramafics, serpentinite, Indus suture, Kohistan arc, Swat.

D/251. Di Pietro, J.A., Ahmad, I. & Hussain, A., 1997a. Field evidence on the emplacement of the Dargai mafic/ultramafic Complex, Malakand area, Pakistan. Abstract volume, 12th Himalaya-Karakorum-Tibet International Workshop, Rome, Italy, 25-26.

The Dargai mafic/ultramafic complex is widely regarded as a klippe of Indus Suture Zone rock obducted onto the Indian plate in the Late Cretaceous or Early Cenozoic during or prior to continent-continent collision (Hussain and others, 1984, Lawrence and others, 1989). An alternative interpretation consistent with recent field mapping suggests that the Dargai mafic/ultramafic complex is not a klippe but is an imbricate slice sandwiched within Indian plate rock. This interpretation more adequately explains the contrasting stratigraphic sequences in Swat and in Malakand (Figure 1). The stratigraphy in Swat consists of Cambrian-Ordovician Swat augen/flaser orthogneiss unconformably overlain by Alpurai group which consist of Carboniferous-Permian Marghazar psammitic schist and amphibolite overlain by Early Mesozoic Kashala schistose marble and Saidu graphitic phyllite. Amphibolite and intrusive rock of any kind are virtually absent in the Kashala and Saidu Formations. The stratigraphy in Malakand consists of Precambrian Pinjkora complex unconformably overlain by Paleozoic (?) Mekhband Formation (both are new names). The Mekhband Formation consists of Kashala-like marble interlayered with amphibolite and intruded by Chakdarra orthogneiss. The abundance of both amphibolite and Chakdarra orthogneiss prevents a direct correlation with the Kashala Formation and suggests instead that the Mekhband is older than both the Kashala and Saidu Formations. Below the Mekhband Formation the Pinjkora complex consists of undifferentiated schist, marble, orthogneiss, and intrusive rock in which Swat orthogneiss is virtually absent. In the southeast part of the area the Mekhband Formation structurally overlies presumably younger Saidu Formation along a contact that is sharp but not intensely sheared relative to the surrounding rock. The contact is interpreted as a pre or syn-metamorphic fault that separates Swat stratigraphy below from allochtonous Malakand stratigraphy above. The Dargai mafic/ultramafic complex is an imbricate slice located between these two stratigraphic sections. In Figure 1, the Main Mantle Thrust (MMT) is shown as the series of faults that lie at separate amphibolite of the Kohistan arc complex from Indian plate rock and Indus melange. These faults show brittle deformation (post-Early Oligocene) with possible right-lateral oblique motion particularly in the Talash-Katgalai area where the Indus melange is cut out. The Ahingaro serpentinite zone represents a brittle deformation zone within Kohistan arc amphibolite that contains slices of serpentinite.

Key Words: Ultramafic rocks, Dargai complex, Malakand, Indian plate.

D/252. Di Petro, J.A., Ahmad, I., Hussain, A. & Isachsen, C.E., 1998. Tectonics of the Indus suture zone in Northwest Pakistan. Geological Bulletin, University of Peshawar 31 (Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop), 53-55.

The Indus suture zone in Northwest Pakistan is composed of three internally imbricated melange slices (Fig. 1). All three slices contain greenstone, serpentinite, talc-schist, and phyllitic schist. The "Swat" melange is characterized by blueschist; the "Dargai" melange by ultramafic rock, and the "Nawagai" melange by marble. The basal fault of each slice is the Kishora, Dargai, and Nawagai fault respectively. The Swat melange extends from the Indus syntaxis westward to Malakand where it is truncated by the Malakand slice which is an allochthonous block of metamorphosed Indian plate rock. Farther west, the Malakand slice is truncated by the Dargai melange which, in turn, is truncated by the Nawagai melange. All four of these fault slices overlie a coherent stratigraphy of metamorphosed Indian plate rock that extends southward to the Khairabad fault. The Main Mantle thrust (MMT) is the boundary between Indus melange and the Indian plate. It is therefore equivalent to the Kishora, Dargai, and Nawagai faults where these faults overlie the Indian plate and is equivalent to the Main Boundary zone (MBZ) of Beck and others (1996). The large-scale fold sequence on the Indian plate is syn-metamorphic, west-vergent, overturned folds followed by late-metamorphic, N-S-trending, open folds. This fold sequence implies that the Indian plate was affected by E-W compression throughout metamorphism and not N-S compression as is widely assumed. The Malakand, Kishora, Dargai, and Nawagai faults are syn-metamorphic faults that pre-date the metamorphic peak in the underlying Indian plate. The Swat melange appears to be the first of the slices to be emplaced. The existence of syn-metamorphic, west-vergent folds on the Indian plate suggests that emplacement may have been from the east or Northeast. Thus, the Swat melange, and the underlying Indian plate, may have been affected by the same west-southwest-vergent deformation that is preserved cast of the Hazara syntaxis. The stacking sequence of the other slices suggests that the Malakand slice, the Dargai melange, and the Nawagai melange were emplaced from the west or northwest following emplacement of the Swat melange. Metamorphism on the Indian plate may have begun as early as 88 Ma based on a concordant U-Pb zircon age from Precambrian gneiss in the Indus syntaxis. This implies that metamorphism was a long-lived event that began with Late Cretaceous ophiolite abduction. Rather than initiate metamorphism, the India-Asia collision resulted in exhumation and cooling of the metamorphic pile between about 67 and 31 Ma. The Kohistan fault is a late- to post-metamorphic fault that cuts across the structural and

metamorphic fabric of the melange slices and the Indian plate. The Kohistan fault completely cuts out melange in areas east and north of the Indus syntaxis and in the area north of the Malakand slice. Final emplacement of the Kohistan is along the Kohistan fault probably occurred in the Oligocene. This emplacement, therefore, has no direct connection to the much older metamorphism that affected the Indian plate and gives no direct information to the timing of initial contact between India and Asia. West of Saidu, the Kohistan fault is a right-lateral strike-slip fault suggesting emplacement of the Kohistan arc from the west or Northwest. Following the emplacement of Kohistan, foreland structures including the Khairabad fault and the MBT transported the metamorphosed Indian plate, the Kohistan arc, and the three melange slices southward as a single block. In Afghanistan, the Kunar fault appears to truncate both the Kohistan arc and the Indus (Nawagai) melange. Indus Melange reappears south of the MBT but intervening faults suggest several 100 kilometres of displacement separating this melange from the three melange slices in the north.
Key Words: Tectonics, structure, Indus Suture.

D/253. Di Pietro, J.A., Baig, M.S., Pogue, K.R., Hussain, A. & Ahmad, I., 1995. Preliminary geologic map of the Indus syntaxis, Pakistan. Abstract Volume, 10th Himalaya-Karakoram-Tibet Workshop, (ETH Zurich) Switzerland.

We present a preliminary geologic map of the Indus Syntaxis (Figure 1) based on 3-1/2 months field mapping by DiPietro and one month by Pogue during the Fall of 1994, unpublished mapping by the Geological Survey of Pakistan under the direction of Hussain, and previous work by the authors (Baig and others 1989, Baig 1990, DiPietro 1990, DiPietro and others 1993; Ahmad 1991, Pogue and others 1992). This research will continue, and the map revised, expanded, and completed during the next three years.
The main observations thus far are: 1) there is no major disruption of stratigraphy west of the Puran fault zone. 2) Stratigraphy is disrupted east of the Puran fault zone by post-metamorphic northerly trending faults. 3) The amount of recent uplift is greatest near the lndus River and decreases toward the west.
A large north to northwest plunging syncline dominates the area west of the Puran fault. This syncline deforms foliation and correlates with the F3 fold phase of DiPietro and Lawrence (1991). Stratigraphy differs slightly on the east and west limbs of the syncline. On the west side, the stratigraphy consists of Swat gneiss overlain by Manglaur formation (these two units are exposed west of the area shown in Figure 1) which, in turn, is overlain by a second layer of Swat gneiss. The Marghazar formation unconformably overlies the Swat gneiss and is followed by the Kashala and Saidu formations. The Kashala formation is unusually thin in the area north of Dosara (Figure 2). On the east limb of the syncline a sequence of interlayered schist, gneiss, amphibolite, and marble crop out along the west side of the Puran fault zone and form the base of the stratigraphic section. These rocks are similar to rock units in the Tanawal and Salkhala formations as described by Calkins and others (1975) along strike to the south. These rocks are intruded by an overlying layer of Swat gneiss except near Derai where the contact is a brittle fault. This layer of Swat gneiss correlates with the lower layer of Swat gneiss that is exposed on the west limb of the syncline. The Swat gneiss, in turn, is overlain by the Manglaur formation. A second layer of Swat gneiss is absent on the east limb. Overlying the Manglaur formation is a new formation named the Duma Formation. Near the middle of the area, the Duma Formation consists of an upper and lower marble member and a middle amphibolite-rich member. The marble is typically white, grey, or banded in appearance. Much of the marble is pure although phlogopite-rich marbles are common arid tremolite or other calc-silicate minerals are locally abundant. Some of the marble is similar in appearance to marble in the overlying Kashala formation, however, marble in the Duma formation is interlayered with amphibolite, minor quartzite and biotite schist. These lithologies are not present in the Kashala formation within the confines of Figure 1. Where the lower contact has been observed, phlogopite-rich marble is consistently interlayered with, or gradational into, biotite schist of the Manglaur formation. Nowhere does the contact appear to be an unconformity. The upper contact is placed where white marble, banded marble, or phlogopite marble is in contact with garnetiferous marble typical of the Kashala Formation. The contact is interlayered or gradational and is consistently near the stratigraphically highest appearance of amphibolite within the Duma formation. The Duma formation can be traced southward around the nose of the syncline to the vicinity of Budal where white marble of the upper marble member pinches out or changes facies with typical dark grey marble of the Kashala formation such that the middle amphibolite member directly underlies the Kashala formation. In addition to amphibolite, the middle amphibolite member contains biotite schist and minor quartzite and marble. Lithologically it is similar to the Marghazar formation. The Marghazar formation and the middle amphibolite member are at the same stratigraphic position, therefore, they are probably the same age (Late Paleozoic). This leaves the age of the lower marble member unresolved. The middle amphibolite member thins and pinches out

toward the north where the Duma formation consists of marble with abundant thin interlayers of amphibolite. Excellent exposures of the Duma formation can be found south of Tangora and east of Alpurai. All of the rock units described above were metamorphosed at least to garnet-grade during Himalayan deformation.

The stratigraphy described above can be followed westward for at least 45 km without crossing a major fault zone (DiPietro and others, 1993). However, eastward, toward the lndus River, the stratigraphy becomes highly disrupted across a series of brittle, post-metamorphic fault zones. These include the Puran, Chakesar, Besham, and Thakot fault zones (Baig, 1990). All of the rock units within these fault zones are Precambrian in age, however, Paleozoic and/or Tertiary granitic rock intrudes the sequence particularly between the Puran and Chakesar fault zones. The faults cut across stratigraphy and show a complicated history that includes a strong component of strike slip displacement. The four major faults converge into a narrow imbricate zone in the vicinity of Kamach and Garhi. From west to east, these faults bring up progressively deeper-seated rock units that culminate with a thick section of Archean and Proterozoic basement gneisses of the Besham group between the Thakot and Besham faults. West of the Besham fault a basement-cover angular unconformity separates graphitic schists and marbles of the Karora group from the Besham group. This unconformity is probably the clearest example within the entire Himalaya of a depositional contact between true Indian shield basement rock and overlying metasedimentary rock. The stratigraphy is complicated between the Puran and Chakesar faults, however, a depositional contact between the undifferentiated Tanawal/Salkhala unit and the Karora group is exposed west of Chakesar. Thus, although disturbed by faults, it may be possible to piece together a complete stratigraphic section from Precambrian basement rock (Besham group) to the Mesozoic cover. However, the stratigraphy is further complicated by the presence of gneisses within the undifferentiated Tanawal/Salkhala sequence. In some areas, the contact between gneiss and schist appears depositional and is consistently marked by a thin sequence of marble and amphibolite. In other areas, the contact between schist and gneiss is knife sharp. One possibility is that these contacts represent pre or syn-metamorphic faults that were later reactivated and/or cut by the younger brittle faults.

The Karora and Besham groups are unique in that they do not show the strong Himalayan-age amphibolite facies metamorphism that affected all of the surrounding rock units (Treloar and others 1989, Baig 1990). The eastern limit of rock not affected by strong Himalayan-age metamorphism is sharply defined by the Thakot fault. The western limit, however, is not well defined. Rocks between the Puran and Chakesar fault zones appear to have been involved in Himalayan-age amphibolite facies metamorphism, therefore, the Chakesar fault zone is tentatively suggested as the western limit of rock not affected by this metamorphism.

The lndus syntaxis region is seismically active. Armbruster and others (1978) defined the lndus-Kohistan seismic zone as extending in a northwest direction through the lndus syntaxis at Besham as well as a second smaller seismically active area in the southern part of the lndus syntaxis surrounding Tarbela Lake. Baig (1990) identified uplifted terraces and deformed Holocene sediments near Besham and Yeats and Hussain (1989) identified late Quaternary deformation in the Tarbela Lake region. In addition, there is a clear increase in relative uplift as the syntaxis is approached from the west. The average height of stream terraces and mountain tops, for example, increases toward the lndus syntaxis Near Budal well preserved stream terraces are 100 m above present-day stream level and, at one location, stream deposits are tilted 340 from the horizontal and are offset by about one meter along a N65E-trending fault. This fault may be part of a conjugate fracture/fault system that includes additional minor brittle faults trending N65E and N65W. It may be significant that the N65W faults are parallel with the trend of the Indus-Kohistan seismic zone.

A working hypothesis suggests that the Indus syntaxis is a strike-slip imbricate zone that formed as a tear fault associated with thrust faulting farther south in the foreland. The brittle faults may have reactivated old fracture and/or fault zones in the Precambrian basement and cut up through the overlying rock. The Besham gneiss may be a sliver of uplifted basement rock caught in the imbricate zone. The older fracture/fault zones may have formed during Late Paleozoic rifting and/or during earlier Precambrian deformation. Active uplift suggests that the Indus syntaxis is an incipient microcosm of Nanga Parbat.

Key Words: Stratigraphy, structural geology, deformation, Indus Syntaxis, Indian plate.

D/254. Di Pietro, J.A., Hussain, A., Ahmad, I. & Khan, M.A., 1999. The character of the Main Mantle Thrust in Pakistan. Abstract Volume, 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany, 32-33.

The Main Mantle Thrust (MMT) represents The tectonic boundary between the metamorphic shield and platform rock of the Indian plate hinterland, and dominantly mafic and ultramafic of the Kohistan-Ladakh arc complex in Pakistan. In some area, this boundary is a sharp planar fault with development of mylonite; in other areas, it is a brittle-ductile imbricate zone; in still other areas, it contains large, discontinuous, slices of internally sheared and deformed ophiolitic melange. The major through-going fault is the Kohistan Fault, which marks the southern boundary of the Kohistan arc from the Afghan border eastward to the Babusar area (Figure 1). The Kohistan Fault is dominantly a right-lateral strike-slip Fault from the Afghan border eastward to Saidu. From Saidu to Babusar, it is a thrust fault with a strong, oblique, right-lateral component. Fault zone fabrics are dominantly brittle and cataclastic, suggesting that the Kohistan Fault is a late to post-metamorphic fault, active in the Oligocene to Early Miocene. East of Babusar, the Kohistan Fault merges with and is reactivated by, the active Raikot Fault, which marks the eastern boundary of the Kohistan arc along the western flank of the Nanga Parbat-Haramosh Massif. The Raikot Fault has been active since at least the Miocene with a strong component of right-lateral strike-slip displacement. The Raikot Fault appears to die out at the NW margin of the massif and it may be the Kohistan Fault that is folded around the north flank of the massif to continue southward as the MMT boundary between the Indian plate and the Ladakh arc along the eastern flank of the massif. In these areas, MMT is marked by a ductile mylonite zone that was active presumably in the Oligocene and Early Miocene, and which again shows a strong component of right-lateral displacement. This contact was subsequently folded, rotated to the vertical, and locally reactivated by brittle shears during exhumation of the Nanga Parbat-Haramosh Massif. Thus, along its entire trace, the Kohistan-Ladakh arc appears to have been displaced in a ESE-direction relative to the Indian plate in the Oligocene to Early Miocene.

From the Naran area eastward, the MMT is a narrow fault zone represented by the Kohistan-Raikot fault system and its continuation on the east side of the Nanga Parbat-Haramosh massif. In these areas ophiolite fragments are sparse. West of Naran, large discontinuous fault slices of ophiolitic melange appear south of the Kohistan Fault and form a separate terrane between the Kohistan arc and the Indian plate. The melange slices have traditionally been considered to be part of an MMT zone equivalent with the Indus Suture Zone. From east to west, the slices are the Shergarh, Kishora, Dargai, and Nawagai melange units (Figure 1). Also present south of the Kohistan Fault, and partly surrounded by melange, is a fault-bound slice of Indian plate rock referred to as the Malakand slice. All five slices are truncated by Kohistan Fault. Contacts between the fault slices and the underlying Indian plate are not intensely sheared relative to the surrounding rock and are folded by late-metamorphic, N-S trending folds that do not deform the Kohistan Fault. This suggests syn-metamorphic emplacement of all five slices. The age of metamorphism indicates that all of the fault slices were emplaced before 50-40 Ma. The maximum age of emplacement is unconstrained and could have occurred as early as the Late Cretaceous. Based on field relationships and stretching lineation data, we suggest that the Shergarh, Kishora, and Dargai slices correlate and that they were emplaced in a southwestward direction. The Nawagai and the Malakand slices are tentatively interpreted to have been emplaced in an E or SE-direction, implying that rotation from SW to ESE-directed transport occurred during metamorphism in western Pakistan, and well before final ESE emplacement of the Kohistan arc in the Oligocene to Early Miocene.

The Kohistan-Raikot fault system is the only through-going structure along the MMT zone. It marks the entire southern and eastern boundaries of the Kohistan arc complex and it may be the Kohistan fault that continues around to form the MMT along northern and eastern flanks of the Nanga Parbat-Haramosh Massif. The Kohistan Fault includes the best known location of the MMT at Jijal and it would seem logical to refer solely to this fault as the MMT. Restricting the definition of the MMT to the Kohistan-Raikot fault system would, however, exclude the large slices of ophiolitic melange which are part of the original definition and which are consistently referred to in the literature as part of the MMT. The Indus Melange, on the other hand, is discontinuous below the Kohistan Fault therefore, no single through-going fault could be considered to be the MMT.

Consistent with the previous usage, we suggest that the melange slices such that the MMT represents the series of faults of different age and tectonic history that collectively mark the northern edge of the Indian plate in Pakistan. Where melange slices are present, the MMT fault line would be placed south of the melange slices, and the northern boundary of the MMT (Indus Suture) zone would be marked by the Kohistan Fault. Where melange slices are absent, the MMT fault line would be represented solely by the Kohistan-Raikot fault system and its continuation along the east side of the Nanga Parbat-Haramosh Massif. This definition follows the original intent of the MMT and is consistent with how the term is used in the literature. The only difference between this definition and the original definition is that the history of the MMT is longer (extending to the active Raikot Fault) and more complicated.

Key Words: Tectonics, structural geology, Indus suture, Kohistan island arc, Indian plate.

D/255. Di Pietro, J.A., Hussain, A., Ahmad, I. & Khan, M.A., 2000. The Main Mantle Thrust in Pakistan: its character and extent. 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, 375-393.

The Main Mantel Thrust (MMT) represents the tectonic boundary between metamorphic shield and platform rock of the Indian plate hinterland, and dominantly mafic and ultramafic rock of the Kohistan-Ladakh arc complex in Pakistan. In some areas, this boundary is a sharp planar fault with development of mylonite; in other areas, it is a brittle-ductile imbricate zone; in still other areas, it contains large, discontinuous, slices of internally sheared and deformed ophiolitic melange. The character of the MMT along its entire trace discussed and it is concluded that there is no single continuous fault, which marks the contact between the Indian plate and the Kohistan-Ladakh arc. On this basis, we propose a revised definition for the MMT that is consistent with both the original definition and with the usage of the term in literature. We suggest that the MMT fault contact be defined as the series of faults, of different age and tectonic history that collectively define the northern margin of the Indian plate in Pakistan. On this basis, faults that define MMT vary in age from Quaternary to possibly as old as Late Cretaceous. Discontinuous lenses of ophiolitic melange that overlie the MMT fault contact, and which intervene between the Indian plate and the Kohistan-Ladakh arc, are considered to be part of an MMT zone that is equivalent with the Indus Suture Zone.
Key Words: Tectonics, structural geology, Indus suture, Kohistan island arc, Indian plate.

D/256. Di Pietro, J.A. & Isachsen, C.E., 1997. An Early Proterozoic age for Precambrian rock units in the Indus Syntaxis, NW Himalaya, Pakistan. Abstract volume, 12th Himalaya-Karakorum-Tibet International Workshop, Rome, Italy, 137-138.

U/Pb zircon ages have been obtained from two intrusive rock complexes, the Kotla and Black Mountain complexes, that crop out in the Indus syntaxis region of the metamorphic hinterland of the Indian Plate (DiPietro and others, 1996). The Indus syntaxis is located along the Indus River generally between the village of Besham in the north and Tarbela Lake in the south. The Kotla complex occurs as sill-like bodies within and near the top of a Precambrian metasedimentary rock sequence that includes the Kotla complex, and the rock selected for zircon dating, is a fine-grained, muscovite-biotite-quartz-feldspar orthogneiss that typically contains small (<0.5 cm) feldspar augen. This rock, which is also found in the Besham intrusive complex, is associated with mafic dikes and sill, leucogneiss, migmatite, and pegmatite. Zircons from the Kotla sample are predominantly small (<100 microns), clear, and equant prisms that yield a preliminary U-Pb age of 1839±9 Ma, which is interpreted as an intrusive age. A fraction of less common larger grains (100 to 200 microns) is discordant and gives a slightly older Pb-Pb age of 1881 Ma indicating the presence of an older inherited component. The age of Kotla orthogneiss corresponds with a U/Pb zircon age of 1852±14 Ma from the Iskere gneiss in the Nanga Parbat region (Zeitler and others, 1989) and with 40Ar/39Ar and K/Ar ages of between 2160 and 1862 Ma on hornblende from mafic dikes in the Besham area (Treloar and others, 1989, Treloar and Rex, 1990, Baig and others, 1989, Baig, 1990). The argon ages from the Besham area were originally interpreted as metamorphic ages but were reinterpreted as intrusive ages by DiPietro and others (submitted).
The Black Mountain complex occurs along the crest of the Black Mountains, which border the eastern side of the Indus River, where it is completely surrounded and intruded by Late Cambrian Mansehra augen gneiss but where it also structurally and topographically overlies the Karora and Gandaf formations. The principal rock in the Black Mountain complex, and the one selected for zircon dating, is a dark, equigranular, fine-grained, biotite-quartz-feldspar orthogneiss. Other subordinate rock types include biotite and/or garnet-bearing gneiss, migmatite, pegmatite, and mafic rock. Zircons from the Black Mountain sample are also predominantly small equant prisms, but contain a greater proportion of larger grains (200 to >450 microns). Preliminary U-Pb data for fractions of large zircons from this sample appear to have experienced severe Pb-loss with a crudely defined lower intercept age of 739±150 Ma. Further abrasion studies will be conducted to better delineate the upper intercept age for this orthogneiss, which is presently unconstrained by the data but consistent with an Early Proterozoic protolith age. Pb-loss may have been contemporaneous with intrusion of the Mansehra augen gneiss which has a whole rock Rb/Sr age of 516±16 Ma (Le Fort and others, 1980).
The ages indicate that the Karora and Gandaf formations are Early Proterozoic or older and suggests further that probable correlative rock units, including the Dakhner Formation in the Attock-Cherat Range, the Manki Formation in the Attack-Cherat and Gandghar Ranges, and the Hazara and Salkhala formations in the Hazara-Kaghan-Kashmir region, are also Early Proterozoic or older and not Late Proterozoic as is widely assumed. The ages and correlations suggest that an early Proterozoic crust is widespread along the northern margin of the Indian Plate. An older

(Archean?) crustal component is exposed in the Besham area the Karora Formation unconformably overlies a sequence of granitic gneiss.
Key words: Chronology, U-Pb ages, Early Proterozoic, Indus syntaxis, Black Mountain, Tanawal, Mansehra.

D/257. Di Pietro, J.A. & Isachsen, C.E., 2001. U-Pb zircon ages from the Indian plate in the northwest Pakistan and their significance to Himalayan and pre-Himalayan geologic history. Tectonics 20(4), 510-525.

U-Pb zircon isotopic ages of seven rock samples are combined with field data to provide constraints on deposition, intrusion, and metamorphism in the northwestern part of the Indian plate (Pakistani) hinterland south of the Indus suture zone in Pakistan. The results suggest deformation, intrusion, and regional metamorphism at ca. 2174 Ma, an event that may correlate with granulite facies metamorphism in the Nanga Parbat area. This was followed by erosion and deposition prior to a second Proterozoic deformation at ca. 1850 Ma, which was associated with widespread intrusion and possibly with low-grade regional metamorphism. Metasedimentary and intrusive rocks of this age are present within the Lesser Himalaya of Nepal but are apparently absent in the High Himalayan crystalline slab north of the MCT. This intrusive/deformational event was followed by erosion and Late Proterozoic (?) deposition with development, in the Cambrian, of an epicontinental, shallow marine shelf. Intrusion in Late Cambrian-Middle Ordovician resulted only in minor uplift/erosion and development of a disconformity. Marine shelf conditions were reestablished in the Middle Paleozoic prior to a widespread intrusive event in the Carboniferous-Permian and normal faulting, erosion, and syndeformational deposition and volcanism in the Late Permian. Marine shelf conditions were reestablished in the Triassic prior to the Himalayan orogeny. Zircons with a concordant age of 89 Ma coupled with field and published isotopic age data suggest that Himalayan deformation and metamorphism in the Pakistani hinterland began between 90 and 75 Ma due to subduction of the Indian plate beneath Indus ophiolitic melange and reached peak amphibolite facies conditions between 70 and 48 Ma. This metamorphism precedes Eocene (54–50 Ma) collision of India with the Kohistan arc complex. Field data suggest that the presently exposed Pakistani hinterland from Afghanistan to Babusar was never significantly overthrust or buried by the Kohistan arc. Rather than initiating the metamorphism, the collision of Kohistan with India resulted in uplift, exhumation, and cooling of the metamorphic pile.
Key words: Chronology, isotopes, U-Pb ages, Precambrian, Early Proterozoic, Indus syntaxis, Black Mountain, Tanawal, Mansehra, Nanga Parbat.

D/258. Di Pietro, J.A. & Lawrence, R.D., 1991. Himalayan structure and metamorphism south of the Main Mantle Thrust, lower Swat, Pakistan. Journal of Metamorphic Geology 9(4), 481-495.

During the Eocene-Oligocene, the Indian plate collided with the Kohistan arc along the Main Mantle Thrust (MMT) zone. The structure of the Lower Swat rock sequence, on the Indian plate directly south of the MMT, is a dome with a basement of granitic gneiss and quartz-rich schist unconformably overlain by amphibolitic and calcareous schist. The earliest superposed small-scale folds (F1 & F2) represent a progressive F1/F2 deformation that is associated with a single set of WSW-vergent large-scale folds (termed F2). These folds are inferred to have developed during oblique, WSW-directed overthrusting of the MMT suture complex onto the Lower Swat rock sequence. Metamorphism began during F1/F2 as indicated by an S1 foliation that developed during biotite-grade metamorphism. S1 is preserved as a relict texture in porphyroblasts that grew during a subsequent interkinematic phase during garnet- and higher grade metamorphism. The dominant, regional foliation (S2) developed following the interkinematic phase. S2 is associated with transposition of S1 and rotation or dismemberment of porphyroblasts. Annealing recrystallization followed S2 and continued during F3 thereby destroying or masking possible pre-existing stretching fabrics. Superposed F3 folds are upright and open with N-S axial trends. They may correlate with early doming of the Lower Swat rock sequence and with strike-slip displacement in the northern part of the MMT zone, north of the Lower Swat area. F3 was followed by retrograde metamorphism and development of E-W-trending, S-vergent F4 folds. F4 may be associated with a final phase of southward directed thrusting and inactivity in the MMT zone. Correlation of published 40Ar/39Ar ages with the metamorphic fabrics suggests that F1/F2 and F3 occurred in the Eocene, and that F4 developed in the Oligocene. F4 is the earliest indication of southward verging structures on this part of the Indian plate.
Key words: Structure, Himalayan deformation, metamorphism, Indian plate, Swat.

D/259. Di Pietro, J.A., Pogue, K.R., Hussain, A. & Ahmad, I., 1996. Precambrian rock of the black mountains NW Himalaya, Pakistan. Abstract volume, 11th Himalaya-Karakoram-Tibet Workshop, Flagstaff, Arizona (USA), 44-45.

The Black Mountains area is a previously unmapped area composed of metamorphic Indian Plate rocks located along the Indus River (Figure 1). Precambrian metasedimentary rocks were variably intruded and metamorphosed in the Precambrian prior to strong Paleogene metamorphic overprint. The rocks are exposed in the south-plunging Indus River anticline which is a late fold that deforms foliation. Earlier deformations are evident by the existence of transposed beds and rootless folds. The anticline is cut by high-angle, post-metamorphic faults oriented roughly parallel with axial trace of the fold. The largest of these faults is the Chakesar fault but stratigraphic relationships suggest only a few kilometers of offset. Numerous minor faults and sheared contacts also occur but these cannot be traced along strike. The field relationships do not support a sharp structural or metamorphic break between the Precambrian rocks and the overlying Paleozoic/Mesozoic sequence. From the base up, the Precambrian metasedimentary sequence is Karora graphitic schist and marble, unnamed Precambrian garnet schist and metasammite and Manglaur/Tanawal quartz mica schist and quartzite. On the west side of the anticline, the Manglaur Formation is unconformably (?) overlain by Paleozoic Duma marble and amphibolite, and Mesozoic Alpurai marble, garnet-calcite schist and graphitic schist. The unnamed unit is a transitional unit with elements of both the Karora Formation (graphitic schist) and the Tanawal Formation (quartz mica schist and quartzite). It is characterized by a distinctive garnet schist marker bed hat can be followed from the vicinity of Thakot southward to the southern edge of Figure 1 and around the nose of the anticline to the vicinity of Martung. The presence of Kotla granitic gneiss, which intrudes the unnamed unit, suggests that he unnamed unit is older than the Tanawal Formation. The contact between the unnamed unit and the Karora Formation appears depositional. The contact between the unnamed unit and the Manglaur/Tanawal Formation is obscured by intrusion of the Swat/Mansehra gneiss. The contact between the unnamed unit and the Mansehra gneiss is sheared in the vicinity of Thakot but southward the contact becomes discordant with abundant cross-cutting relationships. The discordant relationship continues to the southern edge of Figure 1 where Tanawal-like quartzite emerges from below the Mansehra gneiss. These rocks are shown as part of the unnamed unit until additional fieldwork clarifies the relationship between the two units. The Besham complex is composed of undifferentiated orthogneiss of Precambrian and possibly Paleozoic age. West of Besham village, the Besham complex consists of fine-grained biotite gneiss that unconformably underlies the Karora Formation. Elsewhere, the dominant rocks are fine to coarse-grained, leucocratic, biotite-bearing granitic gneisses that are associated with pegmatite. These rocks intrude the Karora Formation whereas other rocks intrude the Karora Formation. North of Martung, a pegmatite/amphibolite sequence, that probably correlates with the Besham pegmatites, intrudes the unnamed unit. The Kotla biotite granitic gneiss (new name) is a sill-like body that intrudes within and near the top of the unnamed unit. The Black Mountain biotite granitic gneiss (new name) is an isolated body within the Mansehra gneiss structurally above the unnamed unit. The Cambrian-Ordovician Swat/Mansehra augen granitic gneiss intrudes the unnamed unit, the Manglaur and Tanawal Formation, the Kotla gneiss, and the Black Mountain gneiss. The structural evolution of the Black Mountain area may parallel the early evolution of Nanga Parbat.
Key words: Sedimentary rocks, metamorphic, Indian plate, Indus river, Swat.

D/260. Di Pietro, J.A., Pogue, K.R., Hussain, A. & Ahmad, I., 1999. Geologic map of the Indus syntaxis and surrounding area, northwest Himalaya, Pakistan. In: Macfarliane, A., Sorkhabi, R.B. & Quade, J., (eds.), Himalaya and Tibet: Mountain root to mountain tops. Geological Society of America, Special Papers 328, 159-178.

The stratigraphic, structure and metamorphism of the hinterland area of the Indian plate in northwestern Pakistan is described in relation to a geologic map. We conclude that this is one of the few areas in the Himalaya where amphibolite facies rock can be traced southward from the Indus-Tsangpo suture zone to low-grade fossiliferous rock without crossing a major fault. The absence of a major fault provides an opportunity to constrain the depositional ages of the metamorphic stratigraphy by direct correlation with fossiliferous rock in conjunction with isotopic dating of intrusive rock. The stratigraphy is divided into the following age groups, each bounded by an unconformity: Early Proterozoic, Late Proterozoic; early-middle Paleozoic, late Paleozoic-Triassic, and Mesozoic. Within this stratigraphy there is evidence for plutonism in the Early Proterozoic, Late Proterozoic, early Paleozoic, late

Paleozoic; and Cenozoic; deformation in the Early Proterozoic and late Paleozoic; and volcanism in amphibolite facies metamorphism in the Late Cretaceous-Cenozoic as result of the obduction of Indus melange onto the Indian plate along the Main Mantle Thrust and the ensuing collision, thrusting, and final emplacement of the Kohistan arc complex along the Kohistan fault.
The Main Mantle Thrust is a pre-metamorphic or syn-metamorphic fault that dates the time of obduction as pre-late Eocene and possibly as Late Cretaceous. Obduction along the Main Mantle Thrust is associated with west-southwest-vergent folds on the Indian plate. Exhumation and cooling of the Indian plate following peak metamorphism may have begun by the late Paleocene or early Eocene in the Indus syntaxis, and by the middle Eocene in the Loe Sar dome. Cooling and exhumation are associated with the development of large-scale, north-south-trending folds that fold the Main Mantle Thrust. The time of initial collision of Kohistan with the Indian plate is unconstrained in the field area, but brittle-ductile fabrics along the Kohistan fault indicate that final emplacement occurred during retrograde metamorphism, probably in the late Oligocene. Final emplacement of Kohistan is associated with the initial development of south-vergent folds on the Indian plate. Neogene and younger deformation is present in the Indus syntaxis area, in contrast to the Loe Sar dome area, where deformation largely ended in the early Miocene. There is no conclusive evidence for pre-Cenozoic amphibolite facies metamorphism in rock as old as Early Proterozoic. Compare Di Pietro et al., 1995.
Key words: Metamorphism, structure, stratigraphy, MMT, Indian plate, Swat, Himalaya.

D/261. Di Pietro, J.A., Pogue, K.R., Lawrence, R.D., Baig, M.S., Hussain, A. & Ahmad, I., 1992. Stratigraphy and dome structure, Lower Swat, Pakistan. Abstract Volume, 7th Himalaya-Karakoram Workshop, Department of Earth Sciences, Oxford University, England, 21.

The metamorphic sequence in Lower Swat is described and placed into the geologic framework of Pakistan. The stratigraphic sequence consists of Precambrian-Cambrian(?) Manglaur formation unconformably overlain by the Alpurai group which is subdivided into the Carboniferous or younger Marghazar formation, and the Triassic or younger Kashala, Saidu, and Nikanai Ghar formations. Type sections are indicated for each rock unit. The rocks crop out in a dome that is truncated on the north side by the Main Mantle suture melange (MMT). The major structures and associated metamorphism are Eocene-Oligocene in age. The earliest structures are west-verging and upright folds, both with ~north-south axial trends. Later east-west trending cross folds produced the dome structure. Geotherrnobarometry on rocks in the center of the dome suggest peak metamorphic conditions at ~600-700 0C and ~9- 11 kbar during development of the early folds. Metamorphism decreases southward to lower greenschist facies in the Peshawar Basin. Comparison with the stratigraphy in the Peshawar Basin indicates that the Lower Swat area existed as a highland with active normal faulting during and perhaps before deposition of the Marghazar formation. The Marghazar formation appears to be a rift facies that correlates with the “agglomeratic slates” and Panjal Traps of western India. The Kashala and Nikanai Ghar formations represent a transition to a stable, shelf environment. These units may correlate, in part, with the Zanskar Super group of western India. The Saidu formation may represent drowning of the shelf as it was pulled down and overridden by the MMT. It may correlate with the Lamayuru Formation of western India. The Alpurai group thus records the entire history, from Late Paleozoic breakup of Gondwana, to development of a Mesozoic passive shelf, to drowning of the shelf during the Himalayan orogeny.
Key words: Metamorphism, structure, stratigraphy, MMT, Swat.

D/262. Di Petro, J.A., Pogue, K.R., Lawrence, R.D., Baig, M.S., Hussain, A. & Ahmad, I., 1993. Stratigraphy south of the Main Mantle Thrust, lower Swat, Pakistan. In: Treloar, P.J. & Searle, M.P. (eds.), Himalayan Tectonics. Geological Society London, Special Publications 74, 207-220.

The metamorphic sequence in Lower Swat is described and placed into the geological framework of Pakistan. The stratigraphic sequence consists of the Precambrian-Cambrian(?) Manglaur formation unconformably overlain by the Alpurai group which is subdivided into the Carboniferous or younger Marghazar formation, and the Triassic or younger Kashala, Saidu, and Nikanai Ghar formations. A third unit, the Jobra formation of unknown age, is present as discontinuous lenses unconformably below the Alpurai group. Type sections are indicated for each rock unit. Comparison with the stratigraphy in the Peshawar Basin indicates that the Lower Swat area existed as a highland with active normal faulting during and perhaps before deposition of the Marghazar formation. The Marghazar formation appears to be a rift facies that correlates with the Panjal Traps of western India. The Kashala and Nikanai

Ghar formations represent a transition to a stable shelf environment. These units may correlate, in part, with the Zanskar Supergroup of western India. The Saidu formation may represent drowning of the shelf as it was pulled down and overridden by the Main Mantle Thrust suture melange. It may correlate with the Lamayuru Formation of western India. The Alpurai group thus records a depositional history from Late Paleozoic breakup of Gondwana, to development of a passive Mesozoic shelf, to drowning of the shelf at the onset of Himalayan orogeny.
Key words: Metamorphism, structure, stratigraphy, MMT, Indian plate, Swat.

D/263. Dogar, A.M., 1985-87. Geological studies of Khanspur Dewal Area with special emphasis on mineralogy and petrology. M.Sc. Thesis, Punjab University, Lahore, 94p.

Key words: Mineralogy, sedimentary petrology, Khanespur, Abbottabad.

D/264. Dong Zhi-Bin, D., Ferrari, R.L., Francis, M.R., Mustil, G., Oswald, G.K.A. & Xiangsong, Z., 1984. Impulse radar ice-depth sounding on the Hispar glacier. In: Miller, K.J. (ed.), The International Karakoram Project, 2, 100-110. Cambridge University Press.

The work carried out by a radio-echo sounding team on the Hispar glacier is described. Results of impulse radar depth-soundings at eleven different sites are given. The measurements are discussed in relation to the effects of surface moraine and melt-water upon the echo signal.
Key words: Glaciology, Hispar, Hunza, Nagar, Karakoram.

D/265. Dougloss, R.C., 1970. Morphologic studies of Fusulinids from Lower Permian of West Pakistan. US Geological Survey Professional paper 643G.

A suite of samples from the Amb Formation in the Salt and Khisor Ranges of West Pakistan has yielded an abundance of fusulinids previously assigned to several species. There are many obvious differences between specimens and between samples in this suite. Traditional comparisons based on measurements at each volution support the idea that the visual differences are real; however, comparisons made at equal radii show great similarities between specimens and between samples. The differences are related to the size of the proloculus and are not considered sufficient evidence for specific discrimination; thus, these specimens are assigned to one species, Monodiexadina kattaensis. A new species, Codonofusiella laxa, occurs in one of the samples with the larger fusulinids and represents the earliest known occurrence of this genus.
Key words: Morphology, palaeontology, Permian, Khisor Range, Salt Range.

D/266. Douville, H., 1924. Le Cretace inferieur de Himalaya, Compte Rendu Societe geologique de France, 59-61.

For additional information, consult the following account.
Key words: Himalaya, Cretaceous.

D/267. Douville, H., 1926. Fossiles receuillis par Hayden dans le Kashmir en 1906 et les Pamirs en 1914; leur description. Geological Survey of India, Records, 58 (4), 349-357, plates 13, 14.

Douville restudies in greater detail the fossils of the Yasin valley collected in 1914 by Hayden. He recorded several Lower Cretaceous fossils. These included the corals, to which he added two genera *Thecosmilia* sp. and *Montastrea* sp.
Key words: Palaeontology, Kashmir, Pamir.

D/268. Drew, F., 1873. Alluvial and lacustrine deposits and glacial records of the Upper Indus Basin; part 1, Alluvial Deposits. Quaternary Journal of the Geological Society of London 29, 441-471.

The tract of country in which occur the deposits of which I propose to give a somewhat detailed though concise account, is that part of the Maharaja of Kashmir's territory which is drained by the Indus. The greater portion of this country has been visited by travellers whose attention has been drawn to the deposits in question, and who have recorded some observations upon them. While considerable light has been thrown by some of these observers, it has seemed to me well both to add my quota and to try to systematize the facts, so as to prevent the confusion likely to arise from mixing, in description, accumulations of various origin, though they may all be classed in one sense as alluvium, and to see what general conclusions can be drawn from all that we have learned. The writers who have told most about the alluvial and lacustrine deposits are Col. H. Strachey, Gen. Cunningham, Dr. Thompson, Major Godwin-Austen, and Dr. Stoliczka. Col. Strachey, whose paper on the Physical Geography of Western Tibet is a wonderful store of accurate and valuable information compressed into a small compass, has given in it a description of the alluvium of the neighbouring basin of the Sutlej, with some reference to the corresponding deposits of the Indus; his conclusions I shall discuss further on. Gen. Cunningham, in his book on Ladākh, has given some notices of lacustrine deposits and of the former extension of lakes, which bear on the subject
Key words: Alluvial deposits, lacustrine deposits, glacial record, Indus basin

D/269. Drew, F., 1874. The upper Indus River. Geological Magazine. (Decade II)/ 1(02), 94-94.

Whenever Colonel Greenwood writes on the subject of rain and river action, we are sure to learn a good deal. I am very glad that he has noticed the facts about the Upper Indus alluviums which I laid before the Geological Society, and has entered into the discussion of their causes. With much that he has written I heartily agree; and if on one point I still differ, it is with a mind open to be convinced if the causes I proposed to account for the present state of the alluvial deposits should seem after further argument either inadequate or unnecessary.
1 grant the "hard gorge and soft valley" theory of Colonel Greenwood generally; in some instances where I have observed the alteration, a difference in in the rocks can be seen to account for it; in others the reason is less clear. Still I am ready to believe that further knowledge of the character and position of the rocks would show that this theory is applicable to most cases. But I feel great difficulty in agreeing that the accumulation and subsequent denudation of thick alluvial deposits were due only to the variation in slope of the river bed. In the first place I cannot see how hundreds of feet of alluvial strata could be formed one upon another in a wide valley ending in a gorge, while the bed of the gorge was sinking from erosion. Secondly, we have the alluvial gravels, to the great thickness, in the gorges as well. This is evident that at the accumulating time, alluviam (of varying degrees of fitness very likely) was deposited though not in all places to the same relative height above its rock bottom, nor probably with one uniform gradient.
Key words: Upper Indus basin, Alluvium, Gorges.

D/270. Drew, F., 1875. The Jummo and Kashmir Terrirories. E. Stanford, London

This is a general account of the Jummu and Kashmir region, including parts of northern Pakistan. It covers geomorphology, geology, and glaciation.
Key words: Jammu, Kashmir, glaciation, sedimentary rocks, Himalaya, Karakorum

D/271. Dubertret, L., 1957. Lexique stratigraphique international... Volume 3. Asie: sous la direction de L. Dubertret. Fascicule 8. a) "India", Pakistan, Nepal, Bhutan. b) "Burma", Birmanie. c) "Ceylon", Ceylan. Publisher: Centre national de la recherche scientifique, Paris.

Key words: Stratigraphy, India, Pakistan.

D/272. Dunbar, C.O., 1940. Permian fusulinids from the Karakorum. Records, Geological Survey of India, LXXV, 1-5.

Key words: Paleontology, Permian, Karakoram.

D/273. Dunkle, D.H., Teichert, C. & Rahman, H., 1963. Stratigraphic research as applied to mineral resources exploitation and development in Pakistan. UN Conference on Application of Science and Technology for the Benefit of Less Develop Areas, Geneva 1963. Natural Resources 2, 173-182.

Key words: Stratigraphy, mineral resources, Pakistan.

D/274. Duroy, Y., 1986. Subsurface densities and lithospheric flexure of the Himalayan foreland Pakistan interpreted from gravity data. MS Thesis, Oregon State University, Corvallis, 74p.

Consult the following account for further details.
Key words: Foreland fold-and-thrust belt, structure, gravity, Kohistan island arc NW Himalaya.

D/275. Duroy, Y., Farah, A. & Lillie, R.J., 1989. Surface densities and lithospheric flexure of the Himalayan foreland in Pakistan. In: Malinconico, L.L. & Lillie, R.J. (Eds.), Tectonics of the Western Himalayas. Geological Society of America, Special Papers 232, 217-236.

Gravity data along a north-south profile from Kohistan to the Punjab plain of Pakistan have been incorporated into recent interpretations of the gross structure of the foreland fold-and-thrust belt of the Himalaya. In northern Pakistan, large deviations from Airy Isostatic equilibrium are observed. An excess of mass characterizes the northern Kohistan arc, and a deficit of mass underlies a broad area extending from southern Kohistan to the Salt Range, while to the south a slight excess of mass seems to prevail in the region of the Sargodha high. This anomalous distribution of mass can be understood if the Indian elastic plate, which is assumed to overlie a buoyant "fluid," is flexed down under the weight of both the overthrust mountains and the sediments eroded off the mountains and deposited in the foredeep basin. In many respects the intracontinental subduction of India beneath the Himalaya is similar to island arc formation, including the seismically active Sargodha high, a basement ridge analogous to the flexural bulge encountered seaward of oceanic trenches. Analysis of Bouguer gravity anomalies along a profile extending from the Sargodha high to the Main Mantle Thrust (MMT) shows that most of the negative-northward gravity gradient can be attributed to crustal thickening. In the Sargodha high area, an additional contribution of about 25 mgal appears to be due to excess of mass at lower crustal or upper mantle levels. The Moho discontinuity is interpreted to bulge up beneath the Sargodha high, then gradually increase in dip from 1° to 3° beneath the Salt Range and Potwar plateau (approximately equal to the change in dip of the basement surface). The Moho is interpreted to change from upwardly convex to upwardly concave beneath southern Kohistan. Finally, north of the Main Mantle Thrust it appears to bend down again, but at a steeper angle of about 15°.
Shorter wavelength anomalies, superimposed on the regional Bouguer gradient, are modeled in terms of upper crustal density changes, including those due to: (1) offsets of the basement surface; (2) variable thickness of the Eocambrian evaporite sequence that forms the basal décollement; (3) thrusting and folding of relatively high-density, older parts of the stratigraphic section to higher structural levels, particularly in the Salt Range and northern Potwar plateau; and (4) thickening of the low-density Neogene molasse sequence into the axis of the Soan Syncline, a structural depression between the Salt Range and northern Potwar plateau. Subsurface densities of the overthrust wedge, as well as the definition of the shape of the top surface of the Indian plate interpreted from seismic reflection and drilling data, place bounds on the flexural rigidity of such a plate and the forces that deform it. In northern Pakistan, a steeper Bouguer gravity gradient suggests that the flexural rigidity of the elastic plate ($D = 4.0 [\pm 2.0] \times 1023$ Nm) is a factor of 10 smaller than the current values interpreted for the central and eastern Himalaya. Moreover, the maximum flexural stresses are probably concentrated within the crust, which may account for the seismic activity of the Sargodha high and southern Kohistan. At the end of the Indian elastic plate (arbitrarily chosen at the MMT), a large positive vertical shear stress, 9.2×1012 N/m < S0 < 1.6×1013 N/m, is applied to account for the topographic load north of the MMT. In addition, to fit the gravity constraints it was necessary to apply a large negative bending moment, -1.4×1018 N < M0 < -0.85×1018N, at the end of the plate. The negative bending moment can be explained by the combined effect of the northward migration of the Indian plate and the southward differential compressional force generated by the crustal rocks stacked at mid-upper crustal levels beneath the northern Kohistan arc. In addition, buoyancy of the crustal rocks at deeper levels beneath the Kohistan arc may contribute to the negative bending moment. Consequently, in southern Kohistan the surface of the Indian plate is

concave up; compressional stresses in the upper part of the plate are probably the primary source of the Hazara seismic zone, where incipient reverse faulting seems to take place. In contrast, the pronounced upward convexity developed along the flexural bulge can account for (1) tensional stress in the upper part of the Indian plate, which is large enough to produce basement normal faults interpreted beneath the Salt Range and Sargodha high; and (2) compressional stress in the lower portion of the crust, which causes the excess of mass and seismicity beneath the Sargodha high.
Key words: Foreland fold and thrust belt, structure, gravity, NW Himalaya.

D/276. Durrani, K.P., 1992. Geology and petroleum potential of the Kohat-Bannu basin, NWFP, Pakistan. Geological Bulletin, University of Peshawar 25, 134-135.

The Kohat Plateau and Bannu depression, a part of the foreland fold and thrust belt of Pakistan, lies to the south of Himalaya and Karakorum mountains on the Indian Plate. The anitclinal structures of Marwat, Khisor, Surghar, and Bhittani Ranges, "the Trans-Indus Ranges", are the southernmost extension of the fold-and thrust-belt. Seismic study suggests that the Kohat-Bannu plateau has been overthrusted to the south along a sole thrust fault, which has also been reported earlier. Many thrust faults, mostly verging to the south and southeast, cut the sedimentary strata, implying that the Kohat-Potwar plateau was thrust southward and south-eastward as a direct consequence of the crustal shortening that resulted from north-south (post-Plaeocene) lateral compression.
A variety of reservoir rocks of carbonate and clastic origin are also present in area. Most of the hydrocarbons in the region have been found in Paleogene rocks but other rocks of Cambrian, Permian, Jurassic and Cretaceous age also show good reservoir qualities.
Key Words: Structure, petroleum potential, Kohat plateau, Bannu basin.

D/277. Durrani, K.P. & Ahmed, I., 1992. Evidence of salt-tectonics in the trans-Indus Salt ranges, NWFP, Pakistan. Geological Bulletin, University of Peshawar 25, 133-134.

The Kohat-Bannu basin is one of the most important zones in an active foreland fold and thrust-belt of Pakistan. It was originated by compressional tectonics at the northern margin of the Indian Plate. This basin is moving southward over a salt layer, which acts as a decollement surface between the Precambrian basement rocks and the Eocambrian-Neogene sediments of the Indian Plate. The Trans-Indus ranges (TIR) are the surface expression of the leading edge of a decollement thrust in which the crystalline basement is not involved. The decollement along the salt in the fold and thrust-belt of Pakistan is formed by the combining processes of sediment load and sliding as a result of north-south compression. Salt behaves like a viscous fluid under stress. When the horizontal compressive stresses exceed the overburden stress of sediment, movement along the salt occurs in the weak zone forming a decollement zone. Some of the salt moves upsection along the thrust faults as a detached salt wedge forming pinch and swell structures. Salt tongues also form in this process.
Key Words: Salt-tectonics, Trans-Indus Salt ranges.

D/278. Durrani, M.M., Muhammad, L. & Zada, N., 1998. Microfacies and environment of deposition of Chorgali Pass Khaire-Murat Range, Punjab, Pakistan. M.Sc. Thesis, University of Peshawar, 8 p.

Key words: Microfacies, depositional environments, Khare Murat, Murree.

D/279. Durrani, N.A., 1983. Ruby mineralization and its relationship with late magmatic metasomatism of Darkut Group in Hunza valley. Geological Bulletin, Balochistan University, 1, 1–7.

Ruby mineralization in marbles and related rocks in Hunza has yielded good quality ruby and some other stones (spinel, green amphibole). This paper relates them to magmatic activity.
Key words: Metasomatism, mineralization, ruby, Hunza.

D/280. Dweeb, M.M., Ibrahim, H. & Yahya, 1976. Geology and the structure of the phosphate bearing rocks west of Kakul, Abbottabad. M.Sc. Thesis, University of Peshawar, 51 p.

Key words: Geology, structure, phosphate, Abbottabad.

D/281. Dyhrenfurth, G.O., 1939. Baltoro, B. Schwabe Verlag, Basel, 32-35.

Key words: Baltoro, glaciers, Karakoram.