F/1. Faccena, C., Lorenzoni, S., Olivieri, L.M. & Lorenzoni, E.Z., 1993. Geo-Archaeology of the Swat Valley (NWFP, Pakistan), in the Charbagh-Barikot stretch, preliminary note. East and West (IsMEO) 43, 257-270.

The Charbagh-Barikot area lies along the Indus suture and contains rocks of the northern edge of the Indian plate as well as those of the suture mélange. There is a whole range of lithologies: pelitic schists (up to kyanite grade), calcareous schists, graphitic schists (commonly garnetifeous), granites and granitic gneisses, greenschists, phyllites, amphibolitized metabasites, and altered ultramafic rocks (serpentinites, magnesite-talc rocks). These rocks have been used in the manufacture of the archeological artifects of the Gandhara age.
Key words: Geoarchaeology, Charbagh, Swat.

F/2. Faisal, S. & Afridi, S.K., 1996-97. Geology of the Kalachitta Hill Range at the western bank of the Indus River south of Nizampur, District Nowshera: Implications for the structural evolution of Main Boundary Thrust. M.Sc. Thesis, University of Peshawar, 70p.

For further details, consult the following account.
Key words: Structure, MBT, Kalachitta, Nizampur, Nowshera.

F/3. Faisal, S., Afridi, S.K. & Khan, M.A., 2001. Structure study at the western bank of the Indus River south of Nizampur, District Nowshera: Implications for the structural evolution of Main Boundary Thrust (MBT). Abstracts, 4th Pakistan Geological Congress, Islamabad, p.62.

The study area is a part of the western Kala Chitta Range, on the right bank of Indus river, around Jhungrai village, Nizampur. An area of about 110 km^2 was studied and mapped to work out the structural patterns. The area comprises, strata ranging in age between Jurassic and Miocene formations. Limestone, shale and sandstones make principle lithologies of the sequence. The region exhibits complex structural features including small and large-scale folds and thrust faults. Two phases of deformation are recognized in the area. An earlier Dl phase that resulted in the development of a large thrust sheet (MBT), which was displaced southward and have resulted in the horizontal shortening and vertical thickening of the region. This thrust (MBT) brings Patala Formation (Paleocene) over the Kuldana Formation (Eocene). The D2 phase not only caused the folding of MIBT but also the rocks underlying the thrust sheet. The subsequent erosion to the D2 folding has exposed younger footwall lithologies in the core of antiforms forming window structures. An open synform between the two such antiformal window structures represents a klippe.
Key words*:* Structure, Main Boundary Thrust, Indus River, Nizampur.

F/4. Falconer, H., 1842. Cataclysm of Indus. The Asiatic Journal, New Series 38, 39.

Falconer has furnished some additional particulars of the grand cataclysm of the river Indus, in the early part of last year. It would appear that the river had been observed, during several months, to be unusually low, so that its deep bed at Attock was converted to an easy ford. All at once, the river burst in an awful debacle through the obstacles which had impeded its course higher up, and rushed down the valley in a mighty flood, sweeping villages and towns away, with thousands of human beings. The Cabul river, which joins the Indus, above the fort of Attock, had its waters held up, and forced back, so as to inundate the towns of Noushera and Akora, in the plains of Peshawur. In the Hazara country, the flood is said to have swept away artillery gum, with many hundred Sikh troops, and the authorities on the Indus report many bodies washed down of a "very foreign" appearance. Dr. Falconer has little doubt that it was occasioned by some un-usual barrier temporarily established in the bed of the river somewhere high up its course, damming up its waters till they attained a volume which overcame the obstruction. He is of

opinion, that the place must have been higher up than Ghilgeet, on the Noobra-tsoh river, or Shayook, above its junction with the Ladakh, or great branch. "During my stay at Iskardoh," he says, "I learnt from the Rajah Ahmed Shah, that great floods occasionally take place, at irregular intervals, in consequence of the Noobra-tsoh getting blocked up by avalanches and masses of ice. This river has one of its principal origins in a great lake, as yet unvisited by Europeans, in the KaraKorum mountains. After winter seasons of unusual severity, the lake gets sheeted over with an enormous mass of ice, and the valley of the river below the lake is liable to be filled up with great avalanches of ice and snow. When events of this kind go together, the disrupted masses of ice from the lake, added to the avalanches, go on accumulating till a huge barrier is formed, which dams up the river, leading to tremendous floods when the water bursts through the obstacle."
Key words: Floods, Indus, Nowshera, Kabul River.

F/5. Falconer, H., 1863/1864. Discussion of Godwin Austen’s paper “Glaciers of the Mustagh Range”. Proceeding, Royal Geographical Society 8, 38-42.

Key words*:* Glaciers, Mustagh Range

F/6. Falconer, H. 1868. Notes on fossil remains found in the Valley of the Indus below Attock, and at Jubbulpoor. In: Murchison, C. (ed.) Palaeontological Memoirs and Notes of the late Hugh Falconer, vol. I. Fauna Antiqua Sivalensis. Robert Hardwicke, London. 414–419.

Key words: Paleontology, Attock, Indus, Jubbulpoor.

F/7. Fantini S.N., 1965. Permian fossils of the upper Hunza Valley. In: Desio, A. (ed.) Italian Expeditions to the Karakorum and Hindu Kush. Scientific Reports 3(1), 135-148. Brill, Leiden.

Key words: Paleontology, Permian, Hunza valley.

F/8. Farah, A., 1976. Study of recent seismotectonics in Pakistan. Report of CENTO Working Group on Recent Tectonics, Istanbul.

Key words: Tectonics, seismology, Pakistan

F/9. Farah, A., Abbas, G., DeJong, K.A. & Lawrence, R.D., 1984. Evolution of the lithosphere in Pakistan. Tectonophysics 105, 207-227.

The geological setting of Pakistan in the framework of the modern concept of plate tectonics is unique in the sense that, within an area of about 800,000 km2, critical tectonic junctions of different interacting plates and microplates are present in an environment where field exposures are excellent.
Here we discuss the dynamics of these various plate boundaries. Two types of active plate boundaries are conspicuous: (1) convergent boundaries characterized by continent-continent collision, obduction, and thrusting in the northern region of the Himalaya and by oceanic crust subduction with a volcanic arc and a wide accretionary wedge in the southern region of Chagai and Makran; (2) a transform boundary, the Chaman transform zone, characterized by very large strike-slip and lesser thrusting. The Chaman transform zone connects the Makran convergence zone, where oceanic lithosphere is being subducted beneath the Lut and Afghan microplates, with the Himalayan convergence zone, where the Indo-Pakistan lithosphere is underthrusting Eurasia. The Chaman zone is at present an intracontinental plate boundary with oblique motion, characterized by north-south strike-slip faults and eastward thrusting and folding in the Kirthar-Sulaiman mountain belt. This mountain belt, the northwestern margin of the Indo-Pak subcontinent, was an

Atlantic-type margin from the late Paleozoic until the Cretaceous. In the Cretaceous, the continental margin became a plate boundary; a thrust belt was formed in the Paleocene, and fragments of the oceanic crust were obducted, either as thrust sheets (Muslimbagh) or as an ophiolitic mélange (Bela and Waziristan).
Key words: Tectonics, Plate tectonics.

F/10. Farah, A. & DeJong, K.A. (eds.), 1979. Geodynamics of Pakistan. GSP, Quetta, 363p.

This is a compilation of 27 papers on, along with an introduction to, the geodynamics of Pakistan. Following introduction there is an account of speculative tectonic history of Pakistan and surroundings. The book covers various aspects of petrology, biostratigraphy, structure (including new tectonics) seismicity, gravity anomaly, paleomagnetism and metallogeny. Abstracts for the papers dealing directly with northern Pakistan are given elsewhere.
Key words: Geodynamics.

F/11. Farah, A., Lawrence, R. D. & DeJong, K.A., 1984. An overview of the tectonics of Pakistan. In: Haq, B.U. & Milliman, J.D. (Eds.), Marine Geology and Oceanography of Arabian Sea and Coastal Pakistan. Von Nostrand Reinhold Co., New York, 161-176.

Key words*:* Tectonics, plate boundaries*.*

F/12. Farah, A. & Mirza, M.A., 1984. Recent crustal deformation and seismicity in Pakistan. Abstract, First Pakistan Geological Congress, Lahore, p.63.

Recent crustal deformation in Pakistan is expressively noticeable along expansive active faults some of which have been the sites of major earth-quakes. Geological features indicating recent movements, historical and instrumental record of earthquakes provide proof of accumulation of crustal strain and deformation causing seismogenic failure of geological material in the zone of 'active faults'. The 'active faults' in Pakistan, comprising large thrusts and strike slip faults splayed into several small fractures, are associated with the Plate Margins where accumulation of strain is taking place. This is happening as a result of the stresses applied by tectonic forces which stem from northward plate motion estimated to be 3-4 cm per year. Evidence are also available for intraplate deformation in the subsurface zones of weakness.
Key words: Tectonics, seismicity.

F/13. Farah, A., & Shah, S.H.A., 1976. Reflections on regional geology and geophysics: Data on the Karakorum Belt and of the burried shield in Punjab. Atti. Dei. Convegi. Lincei, 21, 145–158.

Key words: Tectonics, geophysics, Karakoram.

F/14. Faridi, M.A.F., Anjum, A.R. & Anjum, G., 1981. Algae associated with alluvial gold of Indus at Attock. Geological Bulletin, University of Peshawar 14, 151-157.

Soil algal flora from auiferous alluvials of the river Indus in the vicinity of Attock Fort were studied. In all 31 species belonging to 18 genera were found. The blue green genera were Aphanocapsa (1 sp.), calothrix (1 sp.), Chroococcus (3 spp.), Gloeothece (I sp.), Lyngbya (1 sp.), Merismopedia (1 sp.), Nostoc (1 sp.), Osci!latoria (8 spp.), Phormidium (3 spp.), Stichosiphon (1 sp.) and Symploca (2 spp.). The Chlorophyceae found belong to 6 genera viz., Gloeocystis (1 sp.), Microspora (1 sp.) and Ulothrix (1 sp.). Xanthophyceae was represented by a single plant, Heterococcus. This is the first study of algae found in relation with gold and may help in gold prospecting.
Key words: Algae, gold, Indus.

F/15. Farn, A.E., 1964. Please test emeralds. Journal of Gemology 9, 223-234.

Key words: Gemology, emerald testing.

F/16. Farooq, A., Durrani, M. & Darvaish, M. 1982. Geology of the Sirban Hill area, District Abbottabad. M.Sc. Thesis. Peshawar University, 97p.

Key words: Tectonics, stratigraphy, plate boundaries.

F/17. Farooq, A., 1985-87. The geology and petrography of upper Havelli (District Bagh) & Balligran-Manjhoter (District Muzaffarabad) with special emphasis on Panjal volcanics. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 90p.

The project area covers 150 square miles (417 square kilometers) located in District Bagh and Muzaffarabad, Azad Kashmir. The work has involved geological mapping of the area on a scale of 1:25,000 and 1:15,000 respectively.
This thesis deals with the geology and petrography of the Panjal volcanics. The geological sequence of the area consists of sedimentary, volcanic and metamorphic rocks. The area is tectonically highly disturbed being involved in Himalayan orogeny. Lithologically metamorphic rocks present in the area are schists, slates, phyllites, quartzite and marble. The volcanic rocks have been metamorphosed upto green schist facies. The mineral assemblage in volcanics is p1agioclase+chlorite+ epidote ±quartz ±calcite.
The volcanic rocks belong to two distinct ages. Dogra trap are of Precambrian age and occur within the Dogra slates. Mineralogical studies show these rocks to be Basaltic. The Panjal trap flows are basaltic to andesitic and of Upper Carboniferous age. The pyroclasts occur in association with Panjal trap flows. Petrographic analysis of Panjal volcanics, Agglomeratic slates, limestone and marble have been carried out. Petrogenesis of Panjal volcanics is interpreted. Field evidences and laboratory data reveals that the Panjal volcanics are of submarine origin.
Key words: Petrography, volcanics, Muzaffarabad, Azad Kashmir.

F/18. Farooq, M., 1983-85. Litho-structural studies of Bhirina-Fitni-Paniali and Haddo Bandi Area, District Mansehra. M.Sc. Thesis, Punjab University, Lahore, 162p.

There is a specific relationship between the geological structures, landforms and the climate. This relationship can be worked out by qualitative as well as quantitative analysis of the topographic map. The most commonly exposed lithologies in the project area are schists from chlorite to garnet grade, Susalgali granite gneiss, Mansehra granite, quartzites and hornfelses. The rocks of the project area have been classified into nine lithologic units for the sake of mapping purposes at a scale of 9.2 Cm. to a kilometer on 5.8 inch to a mile. The area is deformed by different deformation phases, among which three are recognized on mesoscopic as well as microscopic scale and area is characterized by heterogeneous deformation. The rocks have been folded isoclinally and later being refolded into open folds. The area lies in the zone of brittle deformation and show extensive fracturing instead of folding. Mesoscopic and microscopic deformational features are well developed in the area. The rocks exhibit effects of polymetamorphism. The thermal metamorphism is superimposed on the regional metamorphism.
Key words: Lithology, structure, Mansehra.

F/19. Farooq, M., 1996. Depositional environments and provenance study of the Warchha sandstone, N.W.F.P., Pakistan. M.Phil. Thesis, University of Peshawar, 75p.

The Warchha Sandstone, of Lower Permian age is present in the Salt and Trans Indus Ranges. Three stratigraphic sections selected for detail study included Warchha Gorge and Zaluch Nala in the Salt Range

and Saiduwali Nala in the Khisor Range. The six lithofacies recognized in the Warchha Sandstone are: 1. Trough cross bedded pebbly sandstone; 2. Pebbly Sandstone/ conglomerate, 3. Cross bedded sandstone, 4. clay/siltstone, 5. Massive sandstone, and 6. Faintly laminated sandstone lithofacies. It is suggested that the Warchha Sandstone is an alluvial fan deposit. The similarity of Warchha Sandstone with the underlying Tobra Formation (in clasts collected and lithology) points either to a common source rock for both formations or indicates reworking and incorporation of Tobra Formation into the Warchha Sandstone. In thin section study; according to QFL triangular diagrams after Folk (1954-1980), the rocks are classified as arkose, with relative abundance of quartz, feldspars (K>P) and lithic fragments. In the QFL provenance discrimination diagrams of Dickinson et al.; (1982, 1983) the point count data occupy the field of continental block provenance. It is suggested by paleoclimatic and paleotectonic characteristics, that the Warchha Sandstone provenance was the area of low relief, humid and semiarid climate with lack of vegetation.
Key words: Sedimentology, provenance, sandstone, Warchha.

F/20. Farooq, M.A., 1985-87. The Geology of Parrai-Dodahera Area, District Swat, NWFP. M.Sc. Thesis, Punjab University, Lahore, 76p.

The topic of this thesis is Geology of Parrai-Dodahera Area with special emphasis on Mineralogy and Petrology. The prescribed area lies in the lower Swat Region. The area consists of about 35 miles2. It lies between latitudes 340 11' 30" to 720 15' 00" in toposheet No. 43 B/2.
The area was mapped by the party through foot traverses on eight times enlarged toposheet at the scale 1:50,000. Notes were taken on different units, their lithology and contact relationship, and geomorphology and also on social set up of the people. Details regarding the structure of the area, i.e., folds, faults, fractures, joints, foliation and lineation were taken. Stations were marked on the map. Samples were also collected. Photographs of geological and geomorphic features were also taken. Back in laboratory, petrographic study of thin section was carried out by microscope.
The project area is not very rich in economic minerals. No mine is present. However, the following rocks and minerals are of economic importance. These are marble, graphitic schist, graphite and garnet.
Key words: Petrology, structure, Swat.

F/21. Farooq, M.S., 1997. Geotechnical study of landslide problems along the Murree-Kohala-Muzaffarabad Road, Pakistan. Institute of Geology, Punjab University, Lahore, Ph.D. Thesis.

Key words: Landslides, Muzaffarabad.

F/22. Farooq, S., 2000. Landslide risk evaluation of a site near Gilgit. Abstracts, Third South Asia Geological Congress, Lahore, p.105.

Key words: Landslides, Gilgit.

F/23. Farooq, S.A. & Jabbar, M., 1985. Geology and petrography of a part of Ambela granitic complex Malandarai area, District Mardan. M.Sc. Thesis, University of Peshawar, 58p.

Area under discussion occupies the south western part of the Ambela granitic complex, it covers about 20 sq. km. area and exposes granite, alkali granite, Biotite granite, Quartz syenite, quartz, chlorite, Carbonate schist, quarts mica schist, Quartz chlorite schist and Epidote muscovite schist. The schistose rocks are belonging to the lower swat Buner schistose group in which the granitic rocks are Implaced on a huge plutonic mass. The rocks are mainly exposed as elongated masses with a general trend, Of NEE conforming the regional trend of the granitic pluton, petrographic studies and field investigation reveals

that it is an alkaline complex and intruded as a large granitic pluton in the Pleistocene unit of the Indian Plate.
Key words: Petrography, petrology, granite, Buner.

F/24. Farshori, M.Z., 1967. Petrographic study of Siwalik sediments in Sihala area near Rawalpindi. Sind University, Science Research Journal 11, 1-11.

Key words: Petrography, Siwaliks, sediments, Rawalpindi.

F/25. Farshori, M.Z., 1968. Decade of mineral development. In: “Pakistan during the decade” (1958-68). Sind University, Special Publication, 75-81.

Key words: Mineral development.

F/26. Farshori, M.Z. & Baig, A.A., 1970. Geological bibliography of the Salt Range, Sulaiman Range, Potwar and Hazara areas. Department of Geology, University of Sind, Jamshoro, 40p.

This is a comprehensive bibliography of both published and unpublished reports. There is an introduction and a list of abbreviations, but no index.
Key words: Bibliography, Salt Range, Sulaiman Range, Potwar, Hazara.

F/27. Farukh, T.M., 1997-99. Geotechnical studies and geological mapping of left saddle embankment of Khanpur Dam Project Area. M.Sc. Thesis, Punjab University, Lahore, 90p.

The project area comprises of Khanpur Dam, its area around reservoir and some area of Haripur- Taxila Road near New Khanpur Town. There are three major aspects of the project work, first to do the geological mapping of the project area, to study the different problems of the dam, and third to perform different tests in detail on the material of the site to assess the properties and utility of these materials in connection with the construction of the dam.
HISTORY OF THE PROJECT
The idea of the dam was based originally, on the development of irrigation. The feasibility studies were undertaken in 1959-60 and an authentic feasibility report was submitted in 1962. After the careful investigation of expert and authorities, the project was started in 1963. The scheduled date of completion of the project was 1973. But the project work was stopped for long due to financial and certain political problems. Ultimately the F.W.O. was called to complete the project as a challenge within a period of one year and F .W .O. completed the project successfully in July 1983 and is onward construction that was completed in 1985.
PURPOSE OF PROJECT
Basically it was planned to construct 137 feet high earthen dam with a reservoir of 5,900-acre feet for irrigation purposes. But later on to meet the needs of municipal and industrial use of Islamabad and heavy engineering complex Taxila, the height of the dam was increased to 167 feet with a reservoir of 1,06,000-acre feet.
LOCATION
Khanpur dam is located on Haro River, about 1 Km South of old Khanpur
Town, where the river flows through a comparatively narrow gorge. The site falls on; a topographic sheet No.43 C/13 of geological survey of Pakistan at coordinates 33degree 48.5' latitude and 72.56 longitudes. The altitude at the dam site ranges from 1830ft to 4450 ft. above sea level. It is very hot in summer, but very pleasant in winter.
Key words: Geotechnical studies, geological mapping, Khanpur Dam.

F/28. Faruqi, F.A., 1967. Properties of glass making sands of Pakistan. Pakistan Journal of Scientific and Industrial Research 5, p.335.

Key words: Glass, sand, Salt Range, Sulaiman Range, Potwar, Hazara.

F/29. Faruqi, F.A., Aslam, M. & Ayub, M., 1966. An investigation of beneficiation of glass sand from Hazara and Sylhet Districts. Pakistan Journal of Scientific and Industrial Research 9, 217-224.

Key words: Glass, Sand, Hazara, Sylhet.

F/30. Faruqi, F.A., Aslam, M. & Ayub, M., 1967. Mineralogy of the Swat kaolinite. Pakistan Journal of Scientific and Industrial Research 10, 58-67.

Fifty one samples of the raw and the beneficiated Swat Kaolinite have been analysed. Two representative samples of the raw and the washed kaolinite have been prepared from 79 samples received and their DTA and X-ray studies made. On the basis of the data obtained, the mineralogy of the deposit and that of the treated kaolinite has been ascertained. X-ray studies indicate that the mineral kaolinite in the raw samples is between 15 to 20%, whereas in the washed samples it is between 45 to 50%.
Key words: Mineralogy, kaolinite, Swat.

F/31. Faruqi, F.A., Beg, M.A., Yusuf, M. & Ayub, M., 1969. Ceramic colours, Part II.- Pink Stains. Pakistan Journal of Scientific and Industrial Research 12, 67-68.

The formation and application of chrome-alumina and chrome-tin pinks were studied. Various compositions were calcined at different temperatures from 1150' to 1350°C. The stains developing good colour were selected and tested in different glaze compositions. Some commercially exploitable stains along with suitable glazes were developed.
Key words: Ceramic colors.

F/32. Faruqi, F.A., Chohan, N.A. & Ashraf, M., 1968. Mineralogy and ceramic properties of West Pakistan feldspars. Pakistan Journal of Scientific and Industrial Research 11, 325-329.

Feldspar samples collected in Hazara District were studied for mineralogical classification and ceramic utility. Specific gravity, chemical composition, IR spectrum, softening temperature, colour of the softened products, thermal expansion and petrography were investigated. Most of the feldspars could be used in the glass and ceramics industries.
Key words: Mineralogy, ceramic, feldspar.

F/33. Faruqi, F.A., Din, A. & Sindhu, S., 1968. Purification of Dera Pezu sands for making colourless and optical glasses. Pakistan Journal of Scientific and Industrial Research 14, p.63.

Key words: Sand, glass, Pezu.

F/34. Faruqi, F.A. & Haq, A., 1962. Properties of some Pakistani bentonites. CENTO Symposium on Industrial Rocks and Minerals, Lahore, 161-165.

Key words: Bentonites.

F/35. Faruqi, F.A. & Qureshi, H., 1965?. Mineralogy of the Ahl kaolinite. Pakistan Journal of Scientific and Industrial Research 17? p.4.

Key words: Mineralogy, kaolinite, Ahl.

F/36. Faruqi, F.A., Safdar, M., Haque, A., Ahmad, M. & Aslam, M., 1970a?. Ceramic properties of Swat clay. Part 1. Physical characteristics. Pakistan Journal of Scientific and Industrial Research 12 (4)?, 66-73.

Key words: Ceramic, clay, Swat.

F/37. Faruqi, F.A. Safdar, M., Haque, A., Ahmad, M. & Aslam, M., 1970b?. Ceramic properties of Swat clay. Part 2. Chemical characteristics. Pakistan Journal of Scientific and Industrial Research 12?, 74-78.

Key words: Ceramic, clay, Swat.

F/38. Faruqi, S.H., 1965a. Report on the Limestone and Dolomite Resources of Surghar Range and Adjoining area, for WPIDC's proposed Kalabagh Steel Mill.

Sizable deposits of workable grades of limestone and dolomite occur in Surghar Range. A total tonnage of 966 million of quarryable reserves of medium and good quality limestone occurring at four different localities has been proved in Chichali, Kalabagh, and Mari – Indus areas. While 921 million tons of quarryable reserves of good to average quality dolomite scattered over three localities, have been established in Gullakhel area (about 15 miles NWW of Jalalpur).
Abundant and cheap labour is available at the localities concerned and the deposits are connected through unmetalled / metalled roads with the chief towns of the area.
Key words: Limestone, dolomite, Surghar Range.

F/39. Faruqi, S.H., 1965b. Report on the Chichali Iron Ore Deposits and their Development.

The total proved and probable iron ore reserves of the workable grade of Chichali area are of the order of 165.5 million tons and 136.5 million tons respectively.
The deposits may be developed by three developmental tunnels namely the "Chapri low – level tunnel", the Muhabbat Khel low level tunnel" and the Muhabbat Khel high – level tunnel". The said tunnels would have to be driven for 5,892 feet, 10,385 feet and 857 feet respectively, to tap the main ore belt. It would be advisable to develop the south limb iron ore deposits, which have not been worked or explored so far, through a connecting drift in between the two low level tunnels. Precautions are to be taken against possible outcome of gas while tunneling the Makerwal stage, Lumshiwal beds and the lower part of Baroch beds.
Key words: Iron ore, Chichali, Lamshiwal.

F/40. Faruqi, S.H., 1966a. Report on the Fireclay Deposits for Kalabagh Steel Mill.

Sizable deposits of the workable grade of Fire Clay occur in Gullakhel, Musakhel and elsewhere in the 'Surghar – Range' and Salt Range at accessible localities. Any one or two of the four proposed deposits may meet the entire requirements of the steel mill for several decades.
Key words: Fireclay, Surghar Range.

F/41. Faruqi, S.H., 1966b. Report on the Sand Deposits for WPIDC's Kalabagh Steel Mill.

The sand horizon occurs as a continuous belt beyond Datta area in both sides along strike and the total reserves actually go to the 'unlimited' extent. However, as a possible source of sand for steel mill, only the triangular area in between the two main tributaries of Datta nala would be considered. This block is exposed from three sides and a considerable portion of the same may be worked open cast.
Key words: Sand, Datta.

F/42. Faruqi, S.H., 1968a. Supplementary Report on Chichali Iron Ore Deposits. Part-1. A critical report on M/S Krupp's Project report on Kalabagh Steel Mill.

Key words: Iron ore, Chichali, Lamshiwal.

F/43. Faruqi, S.H., 1968b. Supplementary Report on Chichali Iron Ore Deposits. Part-2. A critical report on M/S Krupp's Project report on Kalabagh Steel Mill.

Key words: Iron ore, Chichali, Lamshiwal.

F/44. Faruqi, S.H., 1969. Report on Graphite Deposits of Azad Kashmir and their development.

Azad Kashmir has been bestowed sizable deposits of the workable grade of amorphous (cryptocrystalline) and dense phanerocrystalline graphites. The amorphous type is, in general, pure enough to be marketed in as mined state while there are good prospects of concentrating the various phanerocrystalline graphites through the conventional methods of crushing, screening and flotation, on commercial scale. The deposits are comparable, in quite a few respects, to some of the commercial deposits of the world e. g. of Korea, the United States of America and at least some of Russia.
In view of the handsome amounts of foreign exchange involved in the import of graphite and graphite products, it is imperative to appoint some leading graphitic processing and marketing agency as WPIDC's consultants for feasibility studies of Azad Kashmir deposits, with the least possible delay.
Key words: Graphite, Azad Kashmir.

F/45. Faruqi, S.H., 1970a. Graphite Deposits of Azad Kashmir and their Development. National Seminar on Mineral Development, Lahore.

Key words: Graphite, Azad Kashmir.

F/46. Faruqi, S.H., 1970b. Report on Mica Deposits of Gummot – Saral area, Azad Kashmir.

Key words: Mica, Azad Kashmir.

F/47. Faruqi, S.H., 1970c. Report on China Clay Occurrences of Henzal Area Gilgit Agency. Azad Kashmir.

Key words: China clay, Azad Kashmir.

F/48. Faruqi, S.H., 1970d. Utilization of certain indigenous iron ores with local resources. Symposium on Development with Local Resources, Lahore.

Key words: Iron ore, Azad Kashmir.

F/49. Faruqi, S.H., 1970e. Pyrite Deposits of Reshian Azad Kashmir. National Seminar on Mineral Development, Lahore.

Key words: Pyrite, Azad Kashmir.

F/50. Faruqi, S.H., 1970f. Discovery of Limonite Deposits in Reshian Azad Kashmir (urdu article). 12th Science Conference, Lyallpur.

Key words: Limestone, Azad Kashmir.

F/51. Faruqi, S.H., 1972a. "Kalabagh Iron Ore Deposits and their utilization". 13th Science Conference, Karachi.

Key words: Iron ore, Azad Kashmir.

F/52. Faruqi, S.H., 1972b. "Problem of the Establishment of Steel Industry in Pakistan and Local resources. 13th Science Conference, Karachi.

Consult the following account for further details.
Key words: Steel, Indigenous resource.

F/53. Faruqi, S.H., 1972c. Pakistan Steel Mill Problem and its Solution. Proceedings of "First National Seminar on Metallurgy" at the Engineering University Lahore pages 43 - 49.

The main or basic part of the iron and steel industry is the separation of iron from its ore. There are several processes in use to achieve this purpose. Amongst these, under normal conditions, the easiest cheapest and much preferred one is the 'Blast Furnace Process'. If the ore is good enough to be directly charged into the blast furnace it is well and good. But in case, on account of the low grade (low iron high impurities) of ore, it may not be possible then the ore is first upgraded. For blast furnace use the ore should contain at least 35-40% iron with a reasonable amount and balance of other constituents present. It is also necessary that the ore should be in lump form and not as small grains or powder. But in most of the upgrading processes powder or small size results. As such, before charging the upgraded ore (the concentrate) in to the furnace, it is pelletised, briquetted or sintered. Some iron ores, on account of their mineralogical set up do not smelt as such in the blast furnace but they may behave very well in the furnace when converted into sinter. Our Kalabagh iron ore belongs to this type. It is why sintering process has been selected for the proposed Kalabagh Steel Mill.
Key words: Steel mill, Indigenous resource.

F/54. Faruqi, S.H., 1973. Report on the Pezu Iron Ore Deposits of Bannu, Northwest Frontier Province.

The results of a field and laboratory investigations conducted so far on Pezu Iron Ore Deposits are very encouraging and it may be safely reckoned that these deposits would play an important role in the economy of North – West Frontier Province if proper attention is paid to their development. From mining point of view at least, these deposits stand as the best iron ore deposits of the country.
Chemical and mineralogical studies of a number of representative samples collected from surface and underground workings indicate that this ore has a favorable composition from smelting point of view.

Average Iron contents of the ore are 31.3% silica constitutes about 19.8 %, calcium oxide 4.8 % and magnesium oxide 3.6 %. The ore is basically of limonitic-sideritic type. About 68.9 % of the total iron present is in the form of limonite (hydrated iron oxide) and about 27.8 % is in the form of siderite (iron carbonate), the remaining 3.2 % is owed by glauconite (hydrous silicate of iron and potassium with aluminium and magnesium)
With an ore bed thickness of about 16 feet, outcrop extent of about 2 miles and the fact that both ends of the outcrop are structural end rather depositional, the deposits show good prospects of substantial ore reserves capable of supporting a mini steel mill.
Key words: Iron ore, Pezu, Bannu.

F/55. Faruqi, S.H., 1977. Evaluating Rich Ruby Deposits in Northern Pakistan. “World Mining”, California U.S.A.

Key words: Gemstones, ruby, North Pakistan

F/56. Faruqi, S.H., 1978a. Find Report Hunza Ruby Project.

Nature has bestowed Hunza, like its scenic beauty, with an immense wealth of gemstones, both precious and semi-precious. With a thickness or breadth of 7000 to 10,000 feet, the Hunza Ruby Belt which mainly consists of a coarse crystalline richly mineralized marble criss crossed by acid dykes, extends for about 15 accessible miles in strike.
While the Hunza rubies of selected localities compare with or excel in colour and size their counterparts from any source of the world, they lag behind in flawlessness and transparency especially when it comes to bigger size and darker shades.
During the exploratory operations spread over 4.5 years, 1,17,670.695 carats (according to Project's weighment) of rubies, sapphires and ruby spinels were produced. This is in addition to hundreds of thousands of carats illegally extracted by the local people during pre – project period which found their way to the Pakistani and foreign gemstone markets bringing in turn good prosperity to some of the families of Hunza.
Unfortunately no worth considering portion of the rubies recovered during the exploratory operations has been cut or marketed in an open market till the completion of this report due reasons beyond the control of Project's staff. As such nothing can be commented safely regarding the feasibility of the Project.
However the sporadic valuation attempts made in the past of some of the rough and cut stones by some of the foreign and local experts have given quite encouraging results except of course the hurried valuation of the rough stones by the values of the State Gem Corporation of Sri Lanka in April 78 at Peshawar, which gives a rather gloomy picture of the feasibility of the Project.
Key words: Gemstones, ruby, North Pakistan

F/57. Faruqi, S.H., 1978b. Origin of Hunza rubies and nature of the deposits. National Seminar on Development of Mineral Resources, Lahore, 19-31.

The nature of Hunza rubies and their relation to the surrounding geologic environment suggest a hydrothermal origin intead of generally considered regional metamorphic one.
With thickness of 7000 to 10,000 feet, the Hunza Ruby Belt, which mainly consists of a coarse crystalline richly mineralised marble crisscrossed by acidic dykes, extends for about 15 accessible miles in strike.
While the Hunza rubies of selected localities compare well or excell in colour and size their counterparts from any other source of the world, they lag behind in flwlessness and transparency, specially when it comes to bigger size and darker shades.
Key words: Gemstones, ruby, North Pakistan

F/58. Faruqi, S.H., 1983a. Hunza ruby deposit and their genesis. 2nd National Seminar on the Development of Mineral Resources, Peshawar, 1.

Consult the preceding two accounts for further information.
Key words: Gemstones, ruby, genesis, North Pakistan

F/59. Faruqi, S.H., 1983b. Malakand chromite deposits. 2nd National Seminar on Development of Mineral Resources, Peshawar, 1, 5p.

Malakand chromite deposits have been discussed in this paper indicating their occurrences, reserves and grades. The involvement of the PMDC for the exploration and exploitation of these deposits and the beneficiation test work carried out at the PCSIR have also been described.
Key words: Chromite, Malakand.

F/60. Faruqi, S.H., 1983c. Nature and origin of the salt deposits of Pakistan. 2nd National Seminar on Development of Mineral Resources, Peshawar, 1, 18p.

Recent detailed geological investigations for salt in the Salt – Range and Kohat district have given an entirely new picture of the nature and origin of Pakistani salt deposits.
Identification of typical diapiric structures including salt walls salt dykes and "salt flows" over the denuded surfaces of younger formations clearly suggests a diapiric mode of occurrence as against the presently accepted bedded or in situ one.
Prospects of fresh reserves of salt and oil and techniques / approaches for their exploration and exploitation may have to be reoriented in view of the new picture.
Key words: Salt deposits.

F/61. Faruqi, S.H., 1983d. Special features of the geology of Makerwal coal fields. 2nd National Seminar on Development of Mineral Resources, Peshawar, 1, 4p.

Special features of Makerwal's geology are: 1) A low angle thrust undercutting the entire or most of the Surghar – Range placing the Mesozoic and early Tertiary sequence togather in a basin of the younger Siwaliks 2) Structural control of the thickness of Makerwal coal seam and 3) Shale diapirism displayed by the Patala Formation.
In view of the expected disturbances in the deeper workings of the left – over coal areas, future of Makerwal Collieries would depend on a very careful study of the prevailing geological conditions, prudent planning patient development work.
Key words: Coal fields, structure, Makerwal.

F/62. Faruqi, S.H., 1984a. The Salgi oil sand. Abstracts, First Geological Congress, Lahore, 21-22.

Key words: Oil, Sand, Salgi.

F/63. Faruqi, S.H., 1984b. Azad Kashmir ruby deposits. Abstracts, First Pakistan Geological Congress, Lahore, p.24.

Located at a road distance of 112 miles NE of Muzaffarad in the Shontar valley, these newly discovered ruby deposits excel in some respects, when compared to the already known and worked Hunza deposits. However, both gem stone deposits appear to be analogous in age and genesis belonging to the same Darkot Group (Permo-Caboniferous) and of hydrothermal origin.
Since mother marble is well mineralized and extensively developed in the Shontar and adjoining valleys, there are good prospects of locating additional and richer gem stone deposits through intensive exploration.
Key words: Gemstone, ruby, Azad Kashmir.

F/64. Faruqi, S.H., 1984c. Structural similarities between Salt Range and Kohat salt area. First Pakistan Geological Congress, Lahore, p.28.

Structures at the eastern and western extremities of the Salt Range have been found to be surprisingly similar in detail to those at the Kohat Salt area in general, suggesting that these area have identical diapiric and tectonic histories, various evidence are presented in support.
Key words: Structure, Salt Range, Kohat,

F/65. Faruqi, S.H., 1984d. The heterogeneous "Jatta Gypsum" horizon of Kohat. Abstracts, First Pakistan Geological Congress, Lahore, 34-35.

Field investigation in the Kohat salt area have shown that the so called 'Jatta Gypsum' horizon of reportedly Eocene in age actually consist of bodies of gypsum-anhydrite and marl etc. it belongs to four different horizons, ranging in age from Recent to Precambrian (?). Detail of the rocks and subdivision are given.
Key words: Stratigraphy, Jatta Gypsum, Eocene, Kohat

F/66. Faruqi, S.H., 1986. Precambrian Oil in the Salt Range and Potwar Pakistan. Published in vol. 4 Kashmir Journal of Geology

Precambrian rocks, both sedimentary and non-sedimentary types, hold good promise of commercial resources of oil/gas in Pakistan.
Field evidences indicate important relationship between intrusive Khewra Trap and oil / gas shows of the Salt Range Formation (Precambrian). Future development of Precambrian hydrocarbons would, to a considerable extent, depend on the correct understanding of this relationship.
In addition to the conventional structures within immediately overlying reservoir rocks and the internal structures of carbonate zones within Salt Range Formation, there are quite good prospects of Precambrian basement reservoirs in all regions of Salt Range Formation and basement, at workable depths.
Key words: Petroleum resources, Khewra trap, Salt Range formation, Precambrian.

F/67. Faruqi, S.H., 1988. Brief Report on Recent Finds of Precious Metals in Pakistan.

Precious metals (gold, silver and platinum group elements) bearing rock types have been discovered at a number of localities under promising geological environments in Baluchistan, Gilgit, Azad Kashmir, Chitral, Hazara, Waziristan and Punjab.
Comprehensive geological investigations have been recommended at the concerned localities as well as in all regions of similar geology to assess actual potential of precious metals of the country. Side by side, beneficiation and processing tests have been proposed to be undertaken in and outside Pakistan at suitable laboratories on bulk samples to establish commercial processing and exploitation of these deposits.
Immediate drafting and promulgation of incentiveful mineral concession rules, in respect of precious metals, has been strongly recommended in order to attract local and foreign capital and know – how in this relatively new but highly important industrial field.
It has been suggested to commission suitable consultants of international repute to explore various promising precious metal regions of the country with the assistance of local geologists so that the nation could have a realistic assessment of what it has, in a reasonable period of time.
Key words: Precious metals, Gilgit, Hunza, Chitral, Baluchistan.

F/68. Faruqi, S.H., 1989a. Exploration of Precious Metals by PMDC. Seminar on Prospects and Problems of Minerals Based Industries in Pakistan, Peshawar.

PMDC's exploration department has been able to locate some interesting precious metals bearing rocks in different parts of the country. Main areas as per current knowledge are: Gilgit region in the north and the Volcanic Belt of Chagai District (Baluchistan) in the west.
PCSIR Laboratories, Lahore have already evolved, after necessary experimentation, a flow sheet for concentration of at least the precious metals bearing Chilghazi cupriferous magnetite of Baluchistan. Values of copper, platinum, gold and silver in the final flotation concentrate of PCSIR are 22%, 21.8 gms / ton, 5.3 gms / ton and 45.8 gms / ton respectively.
It is unfortunate that no mineral concession rules have as yet been promulgated in the country in respect of precious metals. This is considered necessary if we want any meaningful mineral development.
It is suggested that all prospective mineral deposits in Pakistan should be made open for the public, both local and foreign. This is considered necessary if we want any meaningful mineral development in the country.
Key words: Precious metals, Gilgit, Baluchistan.

F/69. Faruqi, S.H., 1989b. Rock Salt – The Most Potential Mineral Resource of Pakistan. Seminar on Prospects and Problems of Minerals Based Industries in Pakistan, Peshawar.

Key words: Mineral resources.

F/70. Faruqi, S.H., 1990a. Kalabagh iron ore deposits and there economic importance. Abstracts, 2nd Pakistan Geological Congress, University of Peshawar, p.9.

The Kalabagh iron ore deposits could play an important role in the economy Pakistan if they are duly exploited by the establishment of an integrated iron and steel project on the same.
The iron ore deposits are ideally located in respect of the co- occurrence of most other raw materials of the steel industry and in respect of the infrastructure facilities. The deposits are also suitably located with reference to the local markets of their steel mill's finished products.
It would therefore be in the fitness of things to revive the hitherto cold storage 'Kalabagh Steel Mill' and establish it with the least possible delay to initially meet the gap between the current production of the Karachi Steel Mill and the country's actual iron and steel requirements.
Key words: Iron ore, Kalabagh.

F/71. Faruqi, S.H., 1990b. The Kalabagh Dam Site: A critical study. Abstracts, 2nd Pakistan Geological Congress, University of Peshawar, p.14.

The Kalabagh Dam, if constructed at its proposed site, will be unique in the sense that it would be the first dam of its kind and size to have been located on the rim syncline of a salt dome.
Since the massive and still active 'Kalabagh salt dome' is chiefly being fed from the east by the area which is supposed to support the proposed Kalabagh dam and its vast water reservoir, it is feared that additional weight of that magnitude might disturb the present balance of salt extrusion and erosion and might in addition generate enough seismicity to destroy or seriously damage the colossal Kalabagh dam. Accelerated part- subsidence at dam site, simply due to the extra-weight at a particular locality aided of course by the reactivation of the already existing subsidence-fault at and close to the dame site, will be the other and equally important factors to play hell with the safety of the dam.
Prevailing geologic conditions in the Salt Range and the adjoining Kohat salt area suggest that no dam of such magnitude should be thought of in Kalabagh area upto roughly the confluence of Kohat Toi and the Indus located about 33 miles north-east of Kalabagh.
Key words: Damsite, Kalabagh.

F/72. Faruqi, S.H., 1990c. Carbonatite status in Pakistan. Abstracts, 2nd Pakistan Geological Congress, University of Peshawar, 27-28.

So far, according to the available geologic literature, carbonatite a known to occur in Pakistan only at four different localities which are linked together to form the so called 'Alkaline Province Pakistan'. This 'Province' is considered to extend arcuately around Peshawar from Warsak area in the west, Malakand in the north up Tarbela dam in the east. The carbonatite localities are: Loe Shilman (64 Km NW of Peshawar), Malakand, Koga (S. Swat) and Tarbela. Of the four occurrences, Loe Shilman and Malakand are worth considering, the other two are too limited and only of secondary interest. Malakand has no associated alkaline igneous rocks except of course the carbonatite themselves.
Recent studies by the author indicates that the carbonatite situation Pakistan may be very different as these rocks seem to be of quite widespread occurrence in Azad Kashmir, Northern Areas and possibly also in the Volcanic Belt of Chaghai district of Baluchistan.
Field and Lab evidences, though not decisive, indicate that a number of carbonate bodies or masses in northern Azad Kashmir and Gilgit, etc. which have so far been treated as marbles, calcareous schists or xenoliths of calcareous country rocks within the intrusives, could actually be carbonatites. Brief account is given of three such carbonatite (?) occurrences in Shardi-Doarian region of Azad Kashmir and Bagrot and Henzal areas of Gilgit.
There are grounds to suspect that the onyx marble (travertine) of Chagh4 Baluchistan is mothered by burned carbonatite mass thus possibly establishing its analogy with the travertine bodies of the Arkansas River valley in Colorado (USA), which are also believed to owe their origin to the nearby occurring McClure Mountain Carbonatite Complex.
Key words: Carbonatite, Malakand, Loe Shalman.

F/73. Faruqi, S. H., 1990d. Export-Oriented Development of the Rock Salt Deposits of Pakistan. First SEGMITE Conference on Industrial Minerals, Peshawar.

Nature has bestowed upon Pakistan an inexhaustible wealth of high grade rock salt deposits in the Punjab and Frontier provinces. These deposits generally occur at and above normal ground level thus rendering themselves workable through cheap surface as well as sub - surface mining methods.
Rock salt alone may have favorable impact on the economy of this country provided we accept the dictates of nature and exploit these deposits to the optimum extent at competitive rates using modern methods of mining and processing
There are bright prospects of the export of rock salt and its products by Pakistan to the international market including Japan which is the giant importer of salt and its chemicals in Asia.
Kalabagh Warcha and Makerwal salt deposits in the Salt Range (Punjab) and the Bahadurkhel deposits of Kohat / Karak salt area (Frontier Province) show brighter prospects of cheap large scale production.
Key words: Salt deposits, Bahadurkhel.

F/74. Faruqi, S.H., 1990e. Dolomite resources of Surghar and Salt Ranges. Proceedings, First SEGMITE Conference on Industrial Minerals, Peshawar, 29-33.

Inexhaustible deposits of industrial grade dolomite occur in the Northern Surghar Range and the Western Salt Range. The available dolomite belongs to three different stratigraphic horizons namely: the Salt Range Formation (Precambrian), the Jutana Dolomite Formation (Cambrian) and the Kingriali Dolomite Formation (Triassic).
Precambrian horizons are of academic and/or of 'Petroleum Geologists' interest only. Cambrian horizon though extensive but lacks desired purities. Triassic horizon (Kingriali) affords inexhaustible quarryable reserves of industrial grade (both chemical and metallurgical) dolomites both in the Surghar Range and Salt Range. Geology and chemistry of the deposit has been discussed with detailed field and laboratory data.
Key words: Dolomite, Surghar, Salt range, Precambrian, Cambrian, Triassic.

F/75. Faruqi, S.H., 1994. The unique Hunza ruby and sapphire belt. Proceedings, Second SEGMITE International Conference on Export Oriented Development of Mineral Resources and Mineral Based Industries, Karachi, 1994, p.44.

Rubies and Sapphires occur in association with ruby spinels in a coarsely crystalline marble formation with an apparent thickness of 2134 to 3050 meters and strike extent of more than 24 km. The marble is heavily criss crossed by dykes and sills of intrusive igneous rocks: aplite, granite and pegmatite as well as quartz veins.
Mineralization of ruby/sapphire and spinel apparently owes its origin to the intrusives and is considered to be a direct product of their mineralizing solutions acting along suitably positioned and favourably compositioned bedding planes, fissures, fractures and joints of host marble.
The colour of ruby/sapphire is in general, appealing and has a wide range of pink, purple violet to typical pigeon blood red. Transparency is also tolerable but the calcite partitioning, grooving and the general fractured nature of stones are the main drawbacks. However, the area yields the finest quality specimens of ruby, sapphire and spinel with enhanced beauty by the associated ruby mica, green mica (fuchsite) and graphite alongwith golden crystals of the fool's gold (pyrite).
The nature and origin of Hunza rubies is strikingly similar to those of the famous Mogok Ruby Belt of Burma (Myanmar) which has supplied the best rubies to the world for the last 700 years. Potential of the area is great and inexhaustible; systematic exploratory efforts at Hunza may be well rewarded. The exploratory efforts undertaken by PMDC and GEMCP have so far been restricted to simply mining the more accessible areas in crude and haphazard way.
Key words: Gemstone, ruby, sapphire, Hunza.

F/76. Faruqi, S.H., 1996. Granites of Pakistan. Proceedings, Second SEGMITE International Conference on Export Oriented Development of Mineral Resources and Mineral Based Industries, Karachi, 1994, 35-43.

Nagarparkar in south (Sindh) and Mansehra in the north (NWFP) so far were the only source of granites of the country. But recent investigations by Eastern Technique for commercial granites in the Northern Area of Pakistan, specially the Gilgit region, have indicated great potential of variety, quality and quantity. The Karakoram Highway (KKH) with its much relaxed and relatively cheap downhill carriage has eased the transport situation greatly despite a fairly long lead of about 600 km from Islamabad. The unique white, jet black, a variety of shades and textures in white – grey and greenish types along with some of the typical greens bestow superiority to Gilgit granites over all other parts of Pakistan under the present state of geological knowledge.
Key words: Granites, mineral resources, KKH, Nagarparker, Mansehra.

F/77. Faruqi, S.H., 1997a. The unique graphite glacier of Chapursan valley, Gilgit. In: Abstract volume Colloquium on Geology and the Human Life. Pakistan Academy of Geological Sciences, 29-30.

Key words: Glaciers, Chapursan.

F/78. Faruqi, S.H., 1997b. Nature and origin of Salajit. Colloquium on Geology and the Human Life. Pakistan Academy of Geological Sciences, 30-32.

Recent field and laboratory investigations for salajit collection and study of its complete and intact natural bodies along with host rocks have resulted in entirely new concepts regarding the nature and origin of this unique rock product of great medicinal value. Its often claimed origin as: 1) a member of petroleum family (asphalt) 2) latex of some nearby Plants, 3) an alteration product of entombed ancient vegetative material (fossil wood), 4) accumulated dropping of a mountain bird or 5) the urine residue of a rare mountain animal etc. may all be safely discarded on logical and scientific bases. There are quite appealing grounds to suggest the recent coniferous forests growing on hard and fractured igneous rocks and possibly also the mineral biotite [$K(MgFe)_3$ $AlSi_3O_{10}$ (OHF)2 and orthoclase feldspar ($KAlSi_3O_8$) are responsible for the development of salajit. Schistose biotite granite, occurring along lines of major structural disturbances in the Himalayas specially around the peripheries of large intrusive masses of igneous rocks, is the most

favoured host rock, while very steep, vertical to over-hanging bare rock cliffs at high altitudes but still below or adjacent to the coniferous forests, are the most favoured sites of salajit occurrences in Gilgit region which is the largest producer of salajit in Pakistan.
It appears from the prevailing conditions that basically salajit is a bacteria-altered product of accumulated plant material. Possibly it develops at most of the coniferous forests of Northern Areas and elsewhere but comes out as seepages only under favourable conditions of rock and topography. In a hard and fractured or well-jointed but more or less non- porous rock like biotite granite it starts moving downwards along fracture/joint planes due to gravity and comes out at the surface as a seepage on encountering some opening which is invariably provided by some abrupt natural cutting. On the other hand, in porous sedimentary rocks or unfractured and inconspicuously jointed non-porous sedimentary and igneous rocks the salajit fluid is either completely absorbed by the underlying rock or is trapped down localised at or near the site of its origin thus disallowing any salajit seepage to occur. Absence of a steep cutting adjacently below the mother forest will also result in the absence of a salajit seepage despite a suitable host rock.
The slow moving thick acidic salajit fluid along with the still undigested plant material in the form of the fibrous woody pallets etc. and of course with out army of bacteria, apparently attacks the biotite and orthoclase feldspar of the biotite granite and partly dissolves and carries the same on its way downwards and laterally.
Key words: Salajit, Gilgit, Northern areas.

F/79. Faruqi, S.H., 1997c. The graphitized coal deposits of Chapursan valley, upper Hunza valley. Abstracts, National Symposium on Economic Geology of Pakistan, Islamabad, 1p.

A number of characteristics, partially graphitised coal seams have been found to occur in a thick formation of brown weathered, grey-black, thick bedded, hard and compact carbonaceous limestone of possibly Permian age in the Reshit area of Chapursan valley north of Gilgit. The vertically trending coal seams are variable in thickness over short distances apparently due to lateral stresses hut are persistent for several kilometers in strike at both flanks of Reshit Nala. Normal range of thickness is from a few inches to 25 feet. At places, specially at the thicker coal/graphite seams, the amorphous to flaky “secondary” graphite has been found to show tendency of migration to relatively low stress areas and give rise to graphite pockets of’ considerable sizes. At least at one locality ejection of graphite has apparently taken place from a graphite bed consisting of’ partially graphitised coal with alternating hands of carbonaceous limestone. This ejection of graphite, apparently from some of the rich graphite pockets of the otherwise lean graphite bed, has given rise a ‘graphite glacier’ a unique object in the geological realm of the earth. The said graphite glacier maintains a length of about 500 feet and a breadth of 15 to 50 feet. However it seems to be the result of apparently a one-time migration phenomenon rather a still continuous process.
Key words: Coal deposits, Chapursan valley, Hunza.

F/80. Faruqi, S.H., 2000. Feasibility Report Henzal White Granite, Gilgit. A joint report of ETL, GMC and ENFI China, prepared for Zaver Mining Co. Pvt Ltd Islamabad.

So far Nagar Parkar in the south (Sindh) and Mansehra in the north (NWFP) were known to be the only sources of workable granites in Pakistan. But the recent investigations by Eastern Technique for Zaver Mining in Gilgit have resulted in the discovery of a number of workable granite deposits at accessible localities and with inexhaustible reserves. Of these the Farphui’s Black Granite deposit of Bagrot Valley occurring at a road distance of 37 km NE of Gilgit and the unique White Granite Deposits of Henzal Area located 20 km NW of Gilgit are most outstanding and promise to fetch good local and foreign markets. The Basin’s massive grey granite deposits occurring under ideal conditions of working next door to Gilgit to the west show promise of being able to snatch a considerable part of the existing vast market of marble in Pakistan by making available abundant and cheap granite to the masses.
Two schemes of underground mining and open pit quarrying are recommended in this report:-
Total capital cost of the modest Underground Mining Scheme of the Henzal White Granite Deposits for a production of 5000 cubic meters or 100,000 m^2 of squared slabs of granite per annum is Rs. 420 million which is expected to be fully paid back within a period of 6 years.

For surface quarrying or open pit mining, around 930 million rupees would be required for the targeted production and a period of ten years would be required to bring the project into profit.
Key words: Granites, mineral resources, KKH, Nagarparker, Mansehra.

F/81. Fatima, E., Ahmad, N., Siddiqi, F.A. & Khan, A.H., 1983. Chemistry and mineralogy of some Eocene and associated limestones of Kohat District, North West Frontier Province, Pakistan Journal of Scientific and Industrial Research 26, 212-219.

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

F/82. Fatmi, A.N., 1968. The palaentology and stratigraphy of the Mesozoic rocks of Western Kohat, Kalachitta, Hazara and Trans-Indus Salt Ranges, West Pakistan. Ph.D. Thesis, University of Wales, Aberystwyth, 409p.

Key words: Palaentology, stratigraphy, Mesozoic, Kohat, Kalachitta, Hazara.

F/83. Fatmi, A.N., 1969. Diamorphims in some Jurassic and Lower Cretaceous ammonids from West Pakistan. GSP, Geonews 1(2), 6-13.

Key words: Ammonides, Jurassic, Cretaceous.

F/84. Fatmi, A.N., 1971. Late Jurassic and Early Cretaceous (Berriasian) ammonites from Sheikh Budin Hills, Dera Ismail Khan District, North West Frontier Province, Pakistan. GSP, Record 21 (2), 38p.

Key words: Paleontology, Ammonites, Jurassic, Cretaceous, Sheikh Budin, Dera Ismail Khan.

F/85. Fatmi, A.N., 1972a. Lithostratigraphic units of the Kohat-Potwar region. GSP, Information Release 46, 139p.

Key words: Lithostratigraphy, Kohat-Potwar.

F/86. Fatmi, A.N., 1972b. Stratigraphy of the Jurassic and Lower Cretaceous rocks and Jurassic ammonites from northern areas of West Pakistan. British Museum of Natural History Bulletin (Geology) 20(7), 299-380.

The stratigraphy of the Jurassic and Lower Cretaceous formations and Jurassic ammonites from Hazara, Kala Chitta, Nizampur, Western Kohat (Samana range) and the Trans Indus ranges in Northern Pakistan are described.
A provisional zonal scheme is proposed and correlation is suggested with Spiti, Cutch, Madagascar, Mediterranean Province, Middle East, and East Africa. Failure to recognize certain ammonite zones in the area may be explained by non-deposition, slow deposition, unfavourable facies, failure of collection or some combination of these factors. Middle Calovian, Upper Oxfordian and Lower Kimmeridgian ammonites from the Trans Indus range, Upper Oxfordian-Tithonian ammonites from Nizampur, Lower Toarcian ammonites form kala Vhitta and Lower Tithinian ammonites from northern areas of Hazara are recorded and described for the first time. In addition, a definite Aptian amoonite fauna is recognized in parts of Western Kohat and the kala Chitta range. The faunal studies indicate that the Jurassic passes into the Cretaceous without a break in most areas of northern West Pakistan. The najor stratigraphical breaks are Pre-Toarcian, Intra-Jurassic (pre-upper Oxfordian, pre-Kimmeridgian or pre-Tithonian) and intra-Cretaceous (post-Lower-Middle Albian).

Key words: Stratigraphy, Jurassic, Cretaceous, Ammonites.

F/87. Fatmi, A.N., 1973. Lithostratigraphic units of the Kohat-Potwar Province Indus Basin, Pakistan. GSP, Memoir 10, 80p.

Key words: Lithostratigraphy, Kohat-Potwar, Indus Basin.

F/88. Fatmi, A.N., 1974. Some problems of Mesozoic stratigraphy in Hazara and Baluchistan. GSP, Geonews 4, 35-42.

Key words: Mesozoic, Stratigraphy, Hazara, Baluchistan.

F/89. Fatmi, A.N., 1977. Mesozoic. In: Shah, S.M.I. (Ed.), Stratigraphy of Pakistan. GSP, Memoir 12, 29-56.

Key words: Mesozoic.

F/90. Fatmi, A.N., 1992. Mesozoic history of the upper Indus Basin in relation to plate tectonics. Abstracts, First South Asia Geological Congress, Islamabad, 12-13.

Key words: Mesozoic, plate tectonics.

F/91. Fatmi, A.N., Anwar, M., Hussain, I., Saeed, G. & Latif, A., 1990. Stratigraphy of the Shinawari and Datta formations from the Shinawari Area (western Samana Range), Kohat District, Pakistan. Punjab University Geological Bulletin, 25, 47-55.

Stratigraphy of Shinawari Formation is described from the type area of Shinawari on the basis of newly described Boulciceras bed and the overlying maroon shale. Both these units show as key horizons indicating a Lower Toarcian transgression in most areas of Kohat-Potwar Province of the Upper Indus Basin and provide a facies basis of interregional correlation. The clastic shallow water marine sequence below the Bouleiceras beds is placed in the Datta Formation. The Datta Formation in the Samana Range shows a facies change from the type area of Datta in the Surghar Range where the formation is mainly continental. In western Kohat (Samana Range) it is a shore-line to shallow marine sequence as is represented by the frequent carbonate beds with the molluscan and brachiopod fauna and closrics. The two Datta facie are comparable to the Lower Cretaceous Lumshiwal facies which show similar environmental change from continental in the south to marine in the north west of the Trans Indus Ranges.
Key words: Stratigraphy, Shinawari Formation, Datta Formation, Kohat.

F/92. Fatmi, A.N. & Cheema, M.R., 1972a. Late Jurassic and Early Cretaceous (Berriasian) Ammonites from Sheikh Budin Hills, D.I. Khan (N.W.F.P.), Pakistan. GSP, Record48 (2).

Key words: Paleontology, Jurassic, Cretaceous, Ammonites, Sheikh Budin, Dera Ismail Khan.

F/93. Fatmi, A.N. & Cheema, M.R., 1972b. Early Jurassic cephalopod from Khisore-Marwat Ranges (Sheikh Budin Hills, Dera Ismail Khan District, North West Frontier Province, Pakistan). GSP, Record 21(2), 9p.

Key words: Cephalopod, Khisor-Marwat, Sheikh Budin, Dera Ismail Khan.

F/94. Fawad, M., 1986-88. The geology and petrology of Chilas ultramafic complex in the vicinity of Chilas (District Diamar) with special emphasis on petrogenesis of the rock units. M.Sc. Thesis, University of Azad Jammu & Kashmir, Muzaffarabad, Pakistan, 113p.

The project area covers about 368 sq. Km. located in the vicinity of Chilas, District Diamar. The work has involved geological mapping of the area on a scale of 1:50.000. This thesis deals with the geology, petrography and petrogenesis of the Chilas complex and adjacent southern rock units. The possible relation of Chilas complex with the southern Jijal complex has also been discussed. The geological sequence of the area consists of metadiorite rocks of the Chilas complex and granodiorite. The rocks of the Chilas complex are divided into two main associations, the ultramafic-anorthosite association and the main norite/gabbronorite association. Both the associations represent lower and upper cumulates respectively and are in a complicated contact possibly due to syndepositional folding-and faulting. Diorite is the most evolved unit of the Chilas complex.
Field evidences suggest that Chilas complex was intruded into an old pluton, the metadiorite which was included in Kamila amphibolite by Coward (1982). The relationship of Jijal with Kamila amphibolite also shows that the Jijal complex was accommodated in the rocks represented by Kamila amphibolites, suggesting an older age of Kamila rocks than Chilas and Jijal complexes. The Chilas complex is unmetamorphosed and is present in an anticlinal position with ultramafics chiefly restricted to the core of the anticline. The ultramafics are overlain by more evolved rocks i.e. gabbronorite association and diorite capped on both limbs by metadiorite roof rock. On the southern limb, the metadiorite roof rock unit is intruded by a grandiorite pluton which seems to be younger in age than the Chilas complex. Whole of the stratigraphic sequence of Chilas complex is fractionation product of hydrous, magnesian, island arc basaltic magma and there is a strong possibility of finding economic metallic mineral deposits in the Chilas stratified complex.
Key words: Petrology, ultramafics, petrogenesis, Chilas.

F/95. Fayaz, A., 1988. A short note on movement of Dih Glacier causing blockage of the Karakorum Highway. GSP, Information Release, 329, 8p.

On 12th September 1987. Karakoram Highway was closed due to damming of Khunjerab River resulting in a lake about 1 /2 km long. This problem cropped up due to the movement of Dih glacier in the form of mud flow through Dih nulluh.
Dih glacier is a type of surging glacier which creates problems after lapse of many years. Reasons of movement of glaciers, its effects and possible solutions to reconstruct and to keep open the affected part of the Karakoram Highway is the subject of this report.
Out of the three options suggested in this report, the author is obliged to put emphasis on the one that the army engineers are already working on. The method calls for the construction of a new segment of the road along the bank of the lake by filling the available material.
Key words: Glacier, Glacier surge, Karakoram Highway.

F/96. Fayaz, A. & Hussain, H., 1998. Geotechnical report on the proposals for the future planning of Astor valley road, Northern Areas of Pakistan. GSP, Information Release 642, 17p.

During the course or rehabilitation and metalling of the Astore Valley Road, a geotechnical study was carried out on the request of Frontier Works Organization. The aim of this study was to discuss the various proposals under consideration for the improvement of this road.
During the last ten years, more than 250 Million rupees were spent on this project, without achieving its main objective to make it truckable upto Astore. The only hindrance in the fulfillment of this goal is the road portion between Mushkin and Dushkin,
These Slides are complex and a source of constant problem, a detailed study of these slides indicates that the problem is so severe that control of these slides arc prohibitively expensive. Instead of repairing these

slide zones, new alignment proposals arc taken into consideration by shifting the road in this portion to the other side of the river by the construction of two or four bridges, to avoid the unstable areas of both sides.
Keeping in view, the three alternative a comparison was made from the Engineering geology point of view and recommended the realignment of the road on the right bank with two bridges on Astore River.
It is also recommended that before undertaking the project worth of 1032.680 million (Construction of road- Thelichi, KKH -Gorikot-Chilam choki-Minimarg 140 Km), a detailed evaluation from the engineering geology point of view must be undertaken to appreciate the latest techniques available in this field for the future safety or this project.
Key words: Geotechnical, Astore.

F/97. Fayaz, A. & Hussain, S.H., 1999a. Engineering geological studies for road alignment and slope stability along Gupis-Shandur Pass road, Ghizar valley, Northern Areas, Pakistan. GSP. Information Release. 682, 30p.

This report present data, from Gupis to Shandur Pass which is about 107 km long. The whole strip is divided into 30 sections on the basis of material, topography and prominent bridge locations.
The study includes road alignment considerations, land slide investigations, river bed erosion problem and identification of plantation sites. At the end of each section recommendations are proposed for the improvement of the road and remedial measures (or the control and stabilization of slopes.
Presently the road condition from Gupis to Shandur Pass require improvement as only jeeps can cross the Shandur Pass to reach upto Chitral. The widening and realignment proposed in this report will help a great deal for better road link between Gilgit and Chitral, which will ultimately attract more tourists in the country.
Key words: Engineering, slope stability, Gupiz-Shandur, Ghizar valley, Northern areas.

F/98. Fayaz, A. & Hussain, S.H., 1999b. Reconnaissance survey of slope stability and river bed erosion control along Naltar valley road, Northern Areas of Pakistan. GSP, Information Release 674, 21p.

Naltar valley is very famous Tourist resort in Northern Areas. Pakistan Air force (PAF) also maintains a Skiing Resort in this area. The Ministry of tourism and Culture has also proposed to truckable metalled road from the Karakoram Highway by constructing a bridge on Hunza River in front of NomaI village and improving the existing road upto the PAF Skiing Point in this valley. They also planned a tourist resort (five star) to encourage Tourism in this area.
The whole strip is divided into 20 sections depending upon the nature of material/problem envisaged. These sections are of different lengths. A brief description of bridges encountered are also mentioned in this report.
Keeping in view, the type of material/deposits, river position with respect to road, present condition of the road existing gradient of the road, width of the road, suggestions are proposed to improve the gradient, slope stability, river bed erosion to gain the required width. Wherever realignment of the present road found suitable, its proposed and comparison has been given to justify this realignment.
Key words: Slope Stability, erosion, Naltar Valley, Northern areas.

F/99. Fayaz, A. & Khan, K.S.A., 1988. Study of cracks near the village Bara Khaplu subdivision, District Baltistan, Northern Area. GSP, Information Release 363, 12p.

Geological investigations were carried out at Bara village near Khaplu, Baltistan in February, 1988 on the development of a crack about 3 km long in the out-washed material on the western piedmont slope of Bara Pieen hills. The crack is about 2 meter wide and has shown down-warping of talus material by 1.5 to 2 m due to creep movement.
The exposed rocks are of granitic composition and are hard, massive and well jointed. The hill slopes show thick accumulation of talus material derived from the adjacent rocks and comprise big boulders embedded in a heterogenous mixture of coarse sand and fine clay.

Causes of appearance of this crack and land subsidence is apparently due to excessive infiltration of water from the channels called “Kouhls” and slow insipient seepage of snow-melt water into the ground. These channels are unlined and allow the escape of water into the ground which subsequently causes settlement of unconsolidated talus material.
Further development and enlargement of crack and creep of talus material may be checked by controlling the excessive inflow of water into the ground by cementing the irrigation channels. The soil creep may be checked by plantation of quick-growing species of plants along the slope.
Key words: Cracks, Khaplu, Baltistan, Northern areas.

F/100. Fayaz, A., Khan, K.S.A., & Latif, M., 1985. Mudflows and avalanches along the Karakorum Highway. GSP. Information Release 247, 28p.

Landslide investigations were carried out along the Karakoram Highway during the field season 1983-84 on the request of University Grants Commission and the Frontier Works Organization. The problems of the area were thoroughly investigated and classified according to their origin and mode of occurrence.
Mud flows and avalanches along the Karakoram Highway (KKH) from Thakot to Khunjerab pass are discussed in this report. Study of slides include type of rock/material involved in the affected area, reason of its occurrence and remedial measures to check the mass movement phenomenon.
Specific recommendations for each of the affected area are made. These remedial measures are of two types; first, those which can be immediately implemented to check further deterioration; the other ones are for long term measures which will involve more funds and also some restructuring of the KKH plans. However, the second set of remedial measures are very crucial for further safety of the KKH.
Jaglot Gah Mudflow and Harbon avalanche are studied in detail due to their critical position on the KKH as well as their magnitude and repeated occurrences involving large amount of material fall. The recommendations made for these areas should thus be implemented soon.
Continuous maintenance of the KKH requires considerable efforts in terms of time and money. Proper execution and implementation of the recommendations proposed in this report may help a great deal in reducing the manpower and maintenance cost of the KKH.
Key words: Mudflows, avalanches, Karakoram Highway.

F/101. Fayaz, A., Khan, K.S.A. & Latif, M., 1986. Study of landslide problems in rural and urban areas of Murree tehsil. . GSP, Information Release 270.

Fifteen landslides on the link-roads connecting rural areas of Murree Tehsil and the urban area of Murree Town were studied and described in this report. Study of slides include plotting the location of the slides on the maps, type of rocks and material involved in the sliding area, origin and mode of their occurrences and remedial measures. The lithological behaviour of Murree Formation, over-loading of soils by constructing heavy structures ·and unscruplous cutting of trees are mainly responsible for the generation of slides in Murree area.
Proper execution and implementation of the recommendations proposed in this report may · help a great deal in the control and stablization of slopes in the affected areas.
Key words: Landslides, Murree formation, Murree.

F/102. Fayaz, A., Khan, K.S.A., Hussain, S.H. & Latif, M., 2001. Landslides and their control along the Karakoram Highway (Hasanabdal to Gilgit), Vol-II, GSP. Special Publication.

Key words: Landslides, Karakoram Highway, Hasanabdal, Gilgit.

F/103. Fayaz, A. & Latif, M., 1984. Development of cracks in mountain around Sermik village Skardu Sub–division, Northern Area, Pakistan. GSP. Information Release 223.

On the request of Commissioner, Northern Areas, landslide investigations were carried out around Sermik village, Skardu Sub-Division, during the month of February, 1984. The work pertained to the development of cracks in the mountain terrace near Sermik village and probable danger to the life and property of the people of the area.
The affected terrace comprises heterogenous mixture of silt sand and gravel with large embedded boulders. The cracks have developed due to the subsidence of terrace material resting on a downthrown block of an intraformational fault in the granitic body. Excessive seepage and infiltration of rain and snow-melt water have added to the enlargement of these cracks.
The affected terrace may be stabilised by controlling the excessive infiltration of rain and snow-melt water by making catchwater drains, filling and tamping of all open cracks and by plantation of deep rooted and quick growing plants.
Key words: Landslide, Skardu.

F/104. Fayaz, A., & Latif, M., 1988. Rocks excavation problems along Gilgit–Gupis road, Northern Area, Pakistan. GSP. Information Release No. 364, 12p.

Rock Excavation studies along Gilgit Gupis road were carried out during the field season of 1986. The road is 110 Km long and is jeepable in fair weather conditions. Now the work is in progress to make it a metaled road. This report is based on identifying the geological structure and applying it for the excavation of major rock outcrops (locally called Pari). Four of them were measured on 1:200 scale and geological profile were prepared to know the distribution of joints, fractures, faults, shear zones, and other related structures and their impact on drilling and blasting. Based on the rock characteristic various drilling and blasting methods have been suggested for the future safety of the road and to minimize the hazards of land sliding after the construction of the road.
Key words: Excavation, Gilgit-Gupiz, Northern areas.

F/105. Fayaz, A., Latif, M., & Khan, K.S.A., 1985. Landslides evaluation and stabilization between Gilgit and Thakot along the Karakorum Highway. GSP. Information Release No. 253, 49p.

Ten major landslides and a few unstable zone s in a road strip of 350 km long from Thakot to Gilgit along the Karakoram Highway (KKH) are discussed in this report.
Study of slides include plotting of location of the landslide on road log map with respect to their distances from Thakot, types of rock/ material involved in the affected area, origin and mode of their occurrences and remedial measures.
Proper execution and implementation of the recommendations proposed in this report may help a great deal in reducing the man power and maintenance cost of the KKM.
Key words: Landslides, Gilgit, Thakot, Karakoram Highway.

F/106. Fayaz, A., Latif, M., & Khan, K.S.A., 1988. Geology and slope stability studies along Gilgit–Skardu road, Northern Area, Pakistan. Geological Survey of Pakistan. Information Release No. 379, 5p.

Engineering Geological investigations were carried out during 1987-88, along the Gilgit - Skardu Road. These studies included preparation of geological road log map, identification of landslide areas and evaluation of the suitability of various bridge sites under consideration. Contour plans already available were utilized as the base maps for further details of the proposed sites. In all 21 bridge sites and 6 landslide areas were studied and are described in this report.
Gilgit - Skardu road was started after the completion of Karakoram Highway, and the experiences gained at the KKH were effectively utilized during the construction of this road. It has greatly helped in limiting the landslide and slope stability problems on this road as compared to the KKH.
The recommendations proposed in this report may help a great dea1 in stabilizing the slopes and construction of safer bridges on the Gilgit - Skardu Road.

Key words: Slope stability, Gilgit-Skardu, Northern areas.

F/107. Fazali, A., 1969-70. Geological report on Dunga Gali-Kuldana Area, District Hazara. M.Sc. Thesis, Punjab University, Lahore, 90p.

This field report concerns about the findings of geological investigation carried out from Kuldana to Dunga Gali areas. Main emphasis has been placed on structural, stratigraphic and geomorphological aspects. The area shows high relief and for the most part covered with thick vegetation. The degree of exposures is low and the 'ground affords poor opportunity for geological mapping. The rocks exposed in the area range from Jurassic to Eocene in age. A study of the area shows that it has suffered strong tectonic disturbance .A number of folds with almost parallel axes were affected by numerous longitudinal and transverse faults. Different geological cross sections prepared are dealt in the descriptive geology along section C-D. Stratigraphic succession is established, and various formations have been correlated. The geological history of the area is made on the basis of their mineralogical enumerations and from the lithology, fossils and their sedimentary features and environment of the deposition are, also given in this chapter. Opinion is given about the regional tectonics of the Himalayan syntaxial bend on whose western limb area situated. Economically, the area contains a pure enough band of gypsum. Laterite, though economical in its composition, is very small in amount. Two main maps have been prepared by the author; one is lithological which is 3" = 1 mile, one part of the area from Changla Gali -Khaira Gali is enlarged by 9" = 1 mile. The other map is structural, showing main trends of folds and faults.
Key words: Geology, Dunga Gali, Kuldana, Hazara.

F/108. Featherstone, B.K., 1926. The Biafo Glacier. Geographical Journal 67, 351-354.

Key words: Glaciology, Biafo glacier, Baltistan.

F/109. Feistmanter, O., 1880. Notes on the fossil plants from Kathiawar, Sheikh Budin, and Srinagar. Geological Survey of India, Records 13 (1), 62-69.

Key words: Fossil plants, Kathyawar, Sheikh Budin, Srinagar.

F/110. Feistmanter, O., 1882. Note on remains of palm leaves from the (Tertiary) Murree and Kasauli beds in India. Geological Survey of India, Record 15, 51-53.

Key words: Tertiary, Murree, Kasauli, India.

F/111. Felix, G., Michael, S., Pierre, B.J., Bernard, C. & Munir, G., 1999. Kinematics and dynamics of the Himalayan fold-and-thrust belt in Pakistan. Terra Nostra 99 (Abstract Volume, 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany), 59.

The NW Himalayan fold-and-thrust belt in Pakistan runs from the Hazara-Kashmir Syntaxis to the Afghan border. It includes the southern part of the Lesser Himalaya and involves, in places, parts of the Sub Himalaya lying south of, the Main Boundary Thrust (MBT). The MBT and the Hazara-Kashmir Syntaxis dominate the tectonics of this region. The MBT, running all along the Himalayan arc, separates the Indus Basin from the West-Himalayan mountain chain. The Hazara-Kashmir Syntaxis is one of the West-Himalayan Syntaxes where the whole mountain system is sharply bent. The MBT loops around the Hazara-Kashmir Syntaxis, to the east of which no equivalent of the NW Himalayan fold-and-thrust-belt is identified.
Our study area is located in the foothills of the Western Himalaya, 50-km NE of Islamabad, focused on the region between Murree and Nathia Gali (Figure 1). Obviously the development of the MBT and Hazara-Kashmir Syntaxis dominated the deformation of the fold-and-thrust belt, whose understanding required

more dynamic and kinematic arguments. Previous work had given evidence for an imbrication of several thrust sheets in a standard thin-skinned tectonic framework. However, complex models were proposed for the evolution of the Hazara-Kashmir Syntaxis. The area was thus suitable to study the tectonic relationship between thrusting and folding in this part of the Himalayas.

Our study included:

Detailed mapping: A new map with cross-sections will be presented (scale 1:25000).

Describing the lithologies by field observations and thin sections. The belt consists of Jurassic to Eocene low grade metasediments lying unconformably on a basement of Precambrian slates and limestones.

Evaluating the deformational character of the series involved: Imbrication is associated with strike-slip faulting. Carrying out a fault striation analysis using computer aided methods: Various tensors will be integrated in the deformation history. The map and sections show that the fold-and-thrust belt has developed in a multilayered system with layers having contrasting rheologies (e.g. thick limestones interlayered with shales). Lithologies were derived from a passive margin whose sequence is summarized in the following mega-sequences:

Precambrian Hazara slates and limestones (basement).

Unconformable lower Jurassic to upper Cretaceous shallow water marine shelf carbonates and clastics.

Unconformable Paleocene to middle Eocene shallow water limestones and shales, with an upper series of evaporitic marls and mudstones.

Late Eocene to Miocene sediments were deposited in the Himalayan foreland basin and are of shallow marine to continental origin.

Generally steep faults were found. Along the MBT, thrusting and wrenching occurred, but also normal faulting. Combined wrenching and thrusting resulted in positive flower structures well displayed on the map and sections. Folding shows a broad range of styles with most hinges being rather angular. Folds with opposite vergence are seen in several segments of the section. In Mesozoic and Tertiary Formations, synsedimentary normal faults were often reactivated.

The analysis of fault slip data revealed the importance of sinistral strike slip movements along SW-NE-faults. The structural data fit a transpressional regime that has involved the basement. Stress calculations from striations yield a dominant NNW-SSE compression, which, however, cannot explain the whole deformation pattern. A second tensor, with a principal WSW-ENE-compression, was obtained. These two tensors do not have to belong to different phases but instead are the result from a swap between σ_1, and σ_2 in a constriction-dominated stress field. The two tensors were measured at different places, and no clear superposition was found in the field. In addition a constrictional stress ellipsoid was measured in several sites. Shortening across the anticlinal Hazara-Kashmir Syntaxis led to WSW-ENE-compression, which has influenced the region lying west of the syntaxis. The interaction with the SSE-ward Himalayan transport direction produced the regionally complex deformation pattern. This interpretation simplifies previous ones that proposed rotations ci compression directions during the Syntaxis formation. The MBT was bent to its present shape under the influence of the multiple horizontal shortening induced by the constrictional regime. In the core of the syntaxis, shallow marine to continental sediments of the Subhimalaya were folded by an anticline growing vertically, parallel to the extensional axis of the constrictional regime.

Recent seismic activity, neotectonics and geomorphological observations point to the ongoing activity along the frontal Himalayan ranges. Landslides close to the MBT are frequent, and deeply incised valleys with fluvial terraces in a steep topography are common.

Our new maps, sections and structural information point out new features: normal faulting and wrenching along the MBT, inversion tectonics, consistent steep dips and positive flower structures due to combined wrenching and low-angle thrusting. Similar features were recently found in the nearby Kohat plateau by Sercombe et al. (1998).

Key words: Fold and thrust belt, Himalaya.

F/112. Ferguson, R.I., 1984. Sediment load of the Hunza River. In: Miller, K.J. (Ed.), The International Karakoram Project 2, 581-598. Cambridge University Press.

The Hunza River drains 13200-km2 of the western Karakoram Mountains, in which heavily-glaciated mountains rise 5-6000m above arid incised valleys. Measurements by the Pakistan Water and Power Development Authority show the Hunza contributes 22% of the runoff and 39% of the suspended sediment load of the upper 143,000 km2 of the Indus basin. Its sediment yield of 4,800 t km-2a-1, equivalent to a

denudation rate of 1.8mma-1, is amongst the highest in the world but the precise rate is uncertain because of infrequent sampling, considerable short-term and seasonal scatter about sediments rating curves, and big year-to-year variations in load. Ninety-nine percent of annual suspended load is carried in June-September when melt water discharge is maximum and concentrations exceed 10 kg m-3. IKP measurements in summer 1980 showed sediment concentrations in a major proglacial tributary averaged only 12% of those at the basin mouth. This downstream increase, and the pronounced seasonal hysteresis in sediment rating curves, suggest fresh sediment stores are flushed and then depleted not only as melting extends to higher elevations but subsequently as swollen river overtop unvegetated valley floors and undercut terraces. Solute concentrations estimated from electrical conductivity also increase downstream but less so. At the down stream site annual solute yield is estimated as 90 t km-2a-1, three times the world average but only 2% of the solid load. Hydraulic properties calculated from gauging data suggest bedload transport could exceed 100,000 t/day in summer and forms 2-10% of total annual load.
Key words: Sediment, Hunza River,

F/113. Ferguson, R.I., Collins, D.N. & Valley, W.D., 1984. Techniques for investigating melt-water runoff and erosion. In: Miller, K.J. (Ed.), The International Karakoram Project 1, Cambridge University Press.

Meltwater runoff from glaciers and snow fields varies seasonally, with day to day hydrometeorological conditions, and diurnally. Suspended sediment transport is high in Meltwater Rivers but does not have a simple relationship with discharge, and solute concentrations depend on the englacial or subglacial path of the meltwater as well as on rock type. Quantitative understanding of meltwater runoff, solid load and hydro- chemistry in the Alps, Scandinavia, and North America has been improved by continuous monitoring of river conductivity and turbidity as well as stage, automatic water sampling at frequent intervals, and use of atomic absorption spectroscopy and ion-selective electrodes. The sediment removed by meltwater runoff may come from beneath, above or downstream from the glacier. Sources of suspended and dissolved sediment can be inferred crudely from changes in turbidity and conductivity along meltwater routes. They can also be investigated at the microscale by laboratory analysis of rock samples and weathered debris from different altitudes using scanning electron microscopy, X-ray diffraction, microprobe analysis and other techniques already applied to rock debris from the Alps and Hindu Kush. Rockfall contributions can be assessed by time-lapse photography, and bedload transport in meltwater rivers, may be predictable from hydraulic properties obtained during gauging by the velocity-area or dilution methods.
Key words: Glaciology, meltwater runoff, XRD-EPMA data.

F/114. Fernandez, A., 1983. Strain analysis of a typical granite of the Lesser Himalayan cordierite granite belt: The Mansehra pluton, northern Pakistan. In: Shams, F.A. (ed.), Granites of the Himalayas Karakoram and Hindu Kush. Institute of Geology, Punjab University, Lahore, 183-199.

Mansehra pluton is a granite - gneiss complex that has been affected by a markedly heterogeneous deformation. From South to North, a general evolution from granite to thinly laminated gneisses is observed, the bulk strain being highest near the base of the M.M.T.
Three main structural domains have been recognised. In the Southern one, granite predominates over some scarce gneissic zones. Preferred orientation analysis of feldspar megacrysts in the granite reveals that an important flattening component was locally active during intrusion. The Central domain is characterized by coarse grained gneisses which frequently present a well-developed schistosity (s) and a flow cleavage (e), as well as a marked stretching lineation. The gneissification bulk strain evaluated from enclaves and quartz crystals in typical gneisses of this zone, gives a $\lambda 1$ $\lambda 3$ ratio=75. In the Northern domain, the gneisses are thinly laminated and contain scarce feldspar relics. Bulk strain evaluated from enclaves shape data gives $\lambda 1$ $\lambda 3$ ratios as high as 300.
Key words: Mansehra pluton, cordierite, granite, Lesser Himalayan, Mansehra.

F/115. Fielding, E.J., Burbank, D.W., Leland, J., Duncan, C.C. & Isacks, B.L., 1995. Geomorphic Responses of Rapid Denudation Rates in the NW Himalaya and Karakoram. Abstract Volume, 10th Himalaya-Karakoram-Tibet Workshop, (ETH Zurich) Switzerland.

Analysis of high-resolution digital topography for the Kohistan-Karakoram Himalaya area near Nanga Parbat provides new information on the geomorphic response to some of the fastest cooling and denudation rates on the earth. Apatite cooling ages (Zeitler, 1985) and cosmogenic strath terrace ages (Leland et al., 1994; Burbank et al., 1994) both indicate rapid rates of erosion in this area. Measured incision rates range from ~2 mm/yr east of the Nanga Parbat-Haramosh Massif (NPHM) to 6-9 mm/yr where the NPHM is cut by the Indus River gorge. The present topography presumably represents a balance between the tectonic and erosion processes, and the latter have been affected by Quaternary climate changes. Geometric arguments suggest that incision rates are approximately equal to bedrock uplift rates and that these rates have been sustained for ≥0.5 my.

Several quantitative geomorphic measurements have been derived from the digital elevation model (DEM-three arc-second or ~90 m grid), including hillslope angles, local relief, valley widths, and hypsometry. The hillslope angles and local relief were calculated with analysis windows of varying sizes from (~250 m to ~4 km across) to characterize their dependence on scale. The slope of a given window size is defined as the slope of the best-fitting plane to all of the points of that window, while the relief is defined as the difference between the maximum and minimum elevations within the window. Statistics such as slope histograms and hypsometry (elevation histograms) were determined for the studied regions.

Hillslope angles measured with ~250 m windows (the highest resolution reliably determined from this DEM) appear to reflect the dominance of landsliding in hillslope erosion, but not the variations in rock uplift rates in this area. There are no significant differences in slope histograms between the areas of very rapid (6-9 mm/yr) and rapid (~2 mm/yr) denudation. There is a small difference between the slopes in the non-glaciated valleys where slope histograms are narrowly peaked between 30~45O and the generally higher elevation glaciated areas where the slopes have a bimodal histogram with shallow slopes in the valley bottoms and steep slopes along the valley walls. Even in the glaciated zones, there are still only small areas with slopes greater than about 450º. This suggests that the rock-strength limitation on slope is perhaps 45-50o in this region where all of the units are medium- to high-grade crystalline rocks. The relatively narrow range of slopes may reflect a state of self-organized criticality where the rocks are everywhere close to slope failure as in sandbox experiments.

There are also some other areas with shallow slopes that appear to be remnants of low-relief surfaces now at elevations of 4000-5000 m. The most outstanding example is the Deosai plateau, but there are other surfaces with more subtle appearances. These surfaces are expressed as shallow-slope, low-relief areas with large peaks in their hypsometry at an elevation between 4000 m and 5000 m. To the west of the Indus River and NPHM and south of the Hunza and Gilgit Rivers is a low-relief surface at an elevation of about 4300 m, called the Gamugah or Kohistan surface. This surface is remarkably level in its more than 50 km east-west extension. If it is a remnant of a previous regional plateau, it would indicate little or no warping of that surface has occurred since it was formed.

Key words: Topography, geomorphology, denudation, Nanga Parbat.

F/116. Filippi, F.de, 1913-14. The Italian Expedition to Himalaya, Karakoram and Eastern Turkestan. Arnold, London.

Key words: Italian expedition, Himalaya, Karakoram, Turkistan.

F/117. Filippelli, G.M. 1997. Intensification of the Asian monsoon and a chemical weathering event in the late Miocene – early Pliocene: Implications for the Neogene climate change. Geology, 25, 27-30.

Several sedimentary, geochemical, and isotopic records indicate that the hypothesized intensification of the Asian monsoon at about 8 Ma triggered a physical and chemical weathering event in the Himalayan-

Tibetan Plateau. Records of sediment input and clay composition from the northern Indian Ocean reveal clear weathering changes in the plateau at this time, and Ge/Si ratios of opaline silica as well as biogenic sedimentation rates indicate that increased dissolved element fluxes from this weathering event had an ocean wide effect. It is likely that weathering intensity also increased in the Andes and Amazon Basin in this interval as well. Perhaps the most important impact of this weathering event was to increase the net flux of the biolimiting nutrient phosphorus to the ocean, as evidenced by a peak in phosphorus accumulation rates at this time. The temporary increase in nutrient inputs to the ocean triggered increased oceanic productivity and organic carbon burial (recorded in carbon isotopic records and paleooxygen concentrations). The net result of this weathering event may have been an increase in the rate of drawdown of atmospheric CO2 through the late Miocene–early Pliocene, via direct silicate weathering reactions and increased burial of organic carbon in the ocean. This increased rate of atmospheric CO2 drawdown may have destabilized the climate system by the late Pliocene, thus initiating a period of intense cooling and ice buildup leading to the present.
Key words: Monsoon, Chemical Weathering, Miocene, Pliocene.

F/118. Finetti, I., Giorgetti, F. & Poretti, G., 1979. The Pakistani segment of the DSS-profile, Nanga Parbat - Karakul (1974-75). Bollettino di Geofisica Teorica ed Applicata 21, 159-169.

Key words: DSS profile, Nanga Parbat.

F/119. Finetti, I., Poretti, G. & Mirza, M.A., 1983. Crustal structure of the Karakorum Range along the DSS Profile Nanga Parbat-Karakul. Bollettino di Geofisica Teorica ed Applicata (Pamir-Himalaya Volume) XXV, n99-100, 195-209.

Key words: Crustal structure, Karakoram Range, Nanga Parbat.

F/120. Finsterwalder, R., 1936. Die Formen der Nanga Parbat-Cruppe, Topografische-marphologische Begleitworte zu den Karten der Nanga Parbat-Cruppe, Zeitschrift der Gesellschaft fur Erdkunde zu Berlin 71, 321-341.

Key words: Topography, Nanga Parbat.

F/121. Finsterwalder, R., 1937a. Parbat-Cruppe, Topografich-morphologische Begleitwerte zu den Karten der Nanga Parbat-Crupple, Ges, Erdk Berlin, zs. H. 9-10.

Key words: Topography, Nanga Parbat.

F/122. Finsterwalder, R., 1937b. Die geodatischen und topographischen arbeiten bei der Nanga Parbat-Expedition 1934 und ihr Ergebnisse. Zeitschrift fur Vermessungswesen 66, 33-62.

Key words: Topography, Expedition, Nanga Parbat.

F/123. Finsterwalder, R., 1937c. Die Gletscher des Nanga Parbat, Glaziologische Arbeiten der Deutchen Himalaya Expedition 1934 und ihre Ergebnisse. Zeitschrift fur Gletscherkunde 25, 57-108.

Key words: Glaciology, Expedition, Nanga Parbat, Himalaya.

F/124. Finsterwalder, R., 1938. Die geodatischen, gletscherkundlichen und geographischen Ergebnisse der Deutschen, Himalaja-Expidition 34, zum Nanga Parbat. Deutschen Forschungsgemeinschaft, N. F. 2.

Key words: Geodesy, geography, Expedition, Himalaya.

F/125. Finsterwalder, R., 1959. Recent German expeditions to Batura Mustagh and Rakaposhi. Jour. Glaciology, 3, 787-788.

In 1954 a German expedition under the scientific leadership of W. Pillewizer worked in the Batura Mustagh (Hunza-Karakoram) as far as the Rakaposhi Range. Extremely steep mountains are characteristic of this region, also very narrow valleys and gorges. The numerous glaciers have steep icefalls and their tongues are covered with debris except that of the Batura Glacier in the north. The Batura is the largest glacier; it is about 50 km. long. A photogrammetic survey of the whole area of about 3,000 km2 was carried out. On several glacial tongues, especially on the Batura, ice velocities and ablation were also measured. However, owing to the great difficulties caused by the steep and high mountains the survey remained uncompleted. At the end of the expedition a disaster occurred. The geodesist K. Heckler fell to his death into the Hunza Gorge. The preliminary results of the expedition were published in Erdkunde by the geographer, K. Paffen, the glaciologist and photogrammetrist, W. Pillewizer, and the geologist, H. J. Schneider.

In 1959 another expedition, under the leadership of Schneider of Munich, worked in the same region in order to complete the work of 1954. The northern side of the Batura Mustagh could not be visited as an English mountaineering expedition, under the leadership of Dr. Warburton, was at work there. The surveyor of the German 1959 expedition was H. Baumeri of the photogrammetric institute at Munich. He completed the photogrammetric surveys of all the valleys, mountains and glaciers between the Batura Mustagh and the Rakaposhi Range, and again carried out ice velocity measurements in order to determine the mass balance of the glaciers.

Two remarkable events with tragic consequences must be reported. The first was the fact that the monsoon crossed the Himalaya on 2-5 July and reached the Batura Mustagh. This happens about once in 50 years according to the meteorological authorities in Pakistan. As a result there was very heavy precipitation in the valleys for three days and nights. Normally these valleys are very dry and practically without rain for years at a time. At high levels furious snowstorms raged. The Warburton expedition was then probably working on the highest peak of the Batura Mustagh. It must be assumed that Dr. Warburton with his four companions, two Germans among them, was buried by snow and avalanches. The German rescue party of the Schneider expedition could not find any sign of the mountaineers nor even of the four high camps. They had been installed by them on the same glacier which the German mountaineers of the Pillewizer expedition had tried to climb in 1954. The second tragic event took place on 21 August with the sudden burst of a lake dammed by the tongue of one of the big glaciers in the very remote Shimsal Valley, which is an eastern tributary of the Hunza River. It is assumed that it was the Malangutti or the Yazgil Glacier, first found by the Vissers in 1925 and surveyed by K. Mason some years later. The flood caused by the burst had a depth of about 30 m. at the junction of the Shimsal with the Hunza, about 40 km from the assumed position of the lake. The flood destroyed the village of Pasu near this junction, and further on the bridges over the Hunza River were swept away, causing heavy losses. The bursting of the lake had been expected three months before. Perhaps the bursting of the lake was caused by the extraordinary precipitation which had occurred seven weeks earlier. The glaciers of Batura Mustagh are very important for agriculture in the valleys and Alps many kilometres away from the glacier snouts. Irrigation channels lead run-off water to the very dry valley bottoms. These channels begin as near as possible to the end of the glaciers.

Fluctuations of the glaciers have therefore considerable influence on cultivation, but the most critical influence is caused by the damming up of lakes which occurs from time to time and was reported as recently as 1925 by Visser.

Key words: Glaciology, Photogrammetry, Batura, Mustagh, Rakaposhi.

F/126. Finsterwalder, R., 1989. Seit 100 jahren Beobachtungen am minapin gletscher im Hunza karakorum. Zeitschrift fur Gletscherkunde und glazialgeologie 25, 209-216.

Key words: Hunza, Karakoram.

F/127. Finsterwalder, R. & Pillewizer, W., 1939. Photogrammetric studies of glaciers in High Asia. The Himalayan Journal 11, 107-113.

Key words: Photogrammetry, Glaciers, Asia.

F/128. Finsterwalder, R., Raechal, W. & Misch, P., 1935a. The scientific work of the German Himalayan Expedition to Nanga Parbat, 1934. The Himalayan Journal 7, 44-52.

Key words: Himalayan Expedition, Nanga Parbat.

F/129. Finsterwalder, R., Raechal, W. & Misch, P., 1935b. Die wissenschaftlichen Arbeiten der Nanga-Parbat-Expiations 1934. Petermanns Geographische Mitteilungen 81, 1-6.

Key words: Nanga Parbat, Expeditions.

F/130. Finsterwalder, R., & others, 1935. Forschung Am Nanga Parbat. Deutsche Himalaya Expedition 1934, (Varlauf. Bericht unver d wissensch, Anbeiten). Sounderoffentlichung der Geologische Gesellschaft, Hannover, vol. 24.

Key words: Nanga Parbat, Himalaya, Expedition.

F/131. Fiori, G., 1957. Una nuova specie de Seminolus muls. Et Rey dell Karakorum. Atti dell Museo Civico di Storia Naturale de Trieste 21 (2).

Key words: Paleontology, Karakoram.

F/132. Fischer, G., 1932. Petrographische unter suchungen an den won Dr. De Terra im Kun-Lun und Karakorum gesammelten Gesteinen. In: Trinkler, E. (ed.), Wissenschaftliche Ergebnisse der Trinkler'schen Zentralasien-Expidition, Bd. 2. Reimer & Vohsen, Berlin.

Key words: Petrography, Karakoram, Kun Lun.

F/133. Fitch, T.J., 1970. Earthquake mechanisms in the Himalayan, Burmese and Andeman regions and continental tectonics in Central Asia, Journal of Geophysics Rec. 75(14), 2699-2709.

Focal mechanisms are presented for thirteen earthquakes between Hindu Kush and Sumatra, including four shallow-focus events along the Himalayan mountain front and two events at intermediate depth beneath the Burmese mountains. All mechanisms are based on first-motion P- and S-wave data recorded by long-period instruments. The mechanisms along the Himalayan front confirm the existence of thrust faulting for which there is post-Mesozoic geologic evidence. Additional evidence for thrust faulting in central Asia comes from focal mechanisms based on other seismic data published recently by Russian investigators. The axis of minimum compression (the T axis) at intermediate depths beneath the Burmese mountains is oriented approximately down the dip of the seismic zone, as are T axes at intermediate depths in several other

seismic zones. A mechanism solution consistent with strike-slip faulting and another consistent with normal faulting were derived from two shallow earthquakes in western China. One shallow earthquake within the Himalayas yielded a normal faulting mechanism, as did one event from the western margin and two events near the northern border of the Andaman Sea. Slip vectors consistent with under thrusting beneath the Himalayas have a nearly uniform north to northeasterly strike. This evidence, as well as the frequency of occurrence of large-magnitude earthquakes, suggests that seismic slip at shallow depths may account for the convergence between the Indian Ocean and the Eurasian plates along the Himalayan mountain front.
Key words: Tectonics, earthquakes, seismology, structure, Himalaya.

F/134. Fleming, A., 1848. Report on the Salt Range and on its coal and other minerals. Journal and proc Asiatic Society of Bengal, 17, 500-526.

As a member of the Indian Geological Survey, Dr. Andrew Fleming (1822-1901) executed exploration and analysis of the Salt Range in the Punjab reporting on its height, course, and its physical and stratigraphic aspects. He also searched for coal and wood in support of the needs of steamers on the Indus and also sought out gold, copper and other minerals. From his investigations he published Report on the Geology and mineral wealth of the Salt Range in the Punjab.
Key words: Coal, Salt Range.

F/135. Fleming, A., 1852. On the rocks of upper Punjab. British Association for Advancement of Science 22, p.43.

Key words: Geology, lithology, Punjab.

F/136. Fletcher, C.J.N., 1985. Copper mineralization in the Kohistan complex near Dir and Drosh, NWFP. British Geological Survey Circular, 1-65.

Key words: Copper mineralization, Dir, Kohistan.

F/137. Fletcher, C.J.N., Leake, R.C. & Haslam, H.W., 1986. Tectonic setting mineralogy and chemistry of a metamorphosed, stratiform base metal deposit within Himalayas of Pakistan. Journal of Geological Society, London 143, 521-536.

Stratiform Zn-Pb mineralization of probable Proterozoic age occurs in a structurally complex area near the northern margin of the Indian plate around Besham in the North West Frontier Province of Pakistan. The sphalerite and galena mineralization is associated with a well-defined stratigraphy of carbonate, layered calc-silicate quartzite, garnet-bearing quartzo-feldspathic gneiss, feldspathic granulite and albite gneiss. Associated with the ore are varying proportions of pyrrhotite, pyrite, baryte, clinopyroxene, quartz, garnet, actinolite, pyroxmangite, feldspar, carbonate and magnetite. The Mn-rich composition of the silicate minerals and the widespread enrichment of Ba in the rocks associated with the ore form a distinctive signature of the mineralization recognizable in reconnaissance exploration. This signature is distinct from that of skarn minerals formed later in carbonate rocks as a result of the intrusion of pegmatites. The recognition of the stratiform nature of the deposits within a well-defined stratigraphy enhances the exploration potential of the mineralization over a much wider area.
Key words: Mineralogy, chemistry, metamorphism, tectonics, Besham, Himalaya.

F/138. Flohn, H., 1969. About climate and hydrology of the Hindu Kush and the neighbouring high mountains. Erdkunde, Bonn, 23(3), 205–215.

Key words: Climate, hydrology, Hindukush.

F/139. Fluegel, H.W., 1989. Rugosa aus dem Perm des N-Karakorum und der Aghil-Kette. Geologische Paleontologische Mitteilungen (Innsbruck), 17, 101-117.

From the upper Artinskian and/or lower Kungurian of the Hunza region (Pakistan) and the Shaksgam valley (China) coral fauna with genera Ufimia, Paracaninia, Duplocarinia, Yatsengia, Verbeekiella, Euophyllum, Lophophyllidium (Lophillidium), allotropiochisma (?A) and Amandophyllum (?) are described. In addition two new species of the new genus Petraphyllum are named P. hunzaianum and P. columnum. Petraphyllum is characterized by a fanlike arrangement of their septa of naostyp and a septobasal columella. The genus belongs to the new family Petraphyllidae.
The coral fauna shows very close similarities to the cold water "Lytvolasma"-fauna of the Lower Permian of the lhasa- and the Kunlun-Terrane and the Permian corals faunas of the Himalaya_Timor zone, but no affinity to the Waagenophyllum-fauna of the Maokou of the Qiangtang and Lhasa Terrane of Tibet.
Key words: Palaeontology, Permian rugosa, Karakoram.

F/140. Fluegel, H., 1995a. Aphyllum n.sp. (Rugosa) aus der Gircha-Formation des Pakistanischen Karakorum. Neues Jahrbuch fur Mineralogie, Geologie und Palantologie, 166-172.

Key words: Paleontology, Gircha Formation, Karakoram.

F/141. Fluegel, H., 1995b. Permian corals from Chitral (N.W.-Pakistan). Rivista Italian di Paleontologie e Stratigrafia 101, 153-164.

Key words: Paleontology, corals, Permian, Chitral.

F/142. Fluegel H.W. & Gaetani M., 1991. Permian Rugosa from Northern Karakorum and Aghil Ranges. Rivista Italiana de Paleontologia e Stratigrafia 97, 35-48.

Key words: Paleontology, Permian, Karakoram.

F/143. Flynn, L.J., 1981. Biostratigraphy and systematic of Siwalik Rhizomyidae (Rodentia). Ph.D. Thesis, University of Arizona, Tucson, 246p.

Key words: Biostratigraphy, Paleontology, Siwaliks.

F/144. Flynn, L.J., 1982. A revision of fossil rhizomyid rodents from northern Indian and their correlation to rhizomyid biocrhronolgy of Pakistan. Geobios 15, 583-488.

Key words: Paleontology, rodents, India, Pakistan.

F/145. Flynn, L.J., Barry, J.C., Morgan, M.E., Pilbeam, D., Jacobs, L.L. & Lindsay, E.H., 1995. Neogene Siwalik mammalian lineages--species longevities, rates of change and modes of speciation. Palaeogeography, Palaeoclimatology, Palaeoecology 115(1-4), 249-264.

A long depositional sequence from northern Pakistan provides a good fossil record of terrestrial vertebrates for the interval of 18-7 Ma. Making allowances for possible range extensions, we use this record as a direct measure of species longevities. There is a correlation between body size and longevity, smaller mammals frequently being short-lived and larger taxa showing durations up to ca. 10 m.y. The distribution of small mammal longevities indicates an exponential decrease in frequency from a high modal value in the smallest

increment measured (0–200,000 yrs). The most frequent value for large mammals is also the smallest increment measured (1 m.y.), but that distribution may not be unimodal. Small mammal taxa of short duration are concentrated late in the sequence, after 9 Ma especially. The middle Miocene fauna is more stable, with species showing longer durations. The contrast in longevities corresponds with hypothesized greater environmental stability in the middle Miocene. For comparison, the Paleogene sequence of Wyoming indicates short median species durations, with few surveyed taxa lasting over 2 m.y. Siwalik mammals show diverse modes of evolution, but stasis in at least some features is usual, with species boundaries corresponding to morphological breaks. Up to half of the Siwalik rodent and artiodactyl species surveyed likely immigrated from outside the biogeographic province, and for a few, historical data are sufficient to stipulate when and by what route they came to the Indian subcontinent.
Key words: Paleontology, Neogene, Siwaliks

F/146. Flynn, L.J., Pilbeam, D., Jacobs, L.L., Barry, J.C., Behrensmeyer, A.K. & kappelman, J.W., 1990. The Siwaliks of Pakistan: time and faunas in a Miocene terrestrial setting. Journal of Geology, 98 (4), 589-604.

Magnetostratigraphy provides unparalleled chronologic precision for long terrestrial sedimentary records. The Siwaliks of the Potwar Plateau, northern Pakistan, present perhaps the best example of a sequence of well dated faunal horizons spanning most of the Neogene in a single terrestrial biogeographic province. Temporal control on fossil localities tied to multiple paleomagnetic sections is ca. 0.1 m.y., less given special conditions of short magnetozone duration or superpositional relationships. New correlations are presented for two long sections in the lower Siwaliks showing the power and the limitations of magnetostratigraphic correlation within the Siwalik depositional setting. Correlation of Potwar fossil localities to those of an East African section, also dated paleomagnetically, are established with fossil localities from those two biogeographic provinces shown to be coeval on a scale of 105 yr. The composite biostratigraphy rendered by the thick, well exposed, well dated Potwar Siwaliks enables definition of sequential bio- chronologic units without gaps. Utility of the biochronology lies in correlating isolated deposits to the Potwar composite; for studies within the Potwar, locality relationships and the biostratigraphy itself are the operational units. The history of the Siwalik fauna shows turnover episodes, but they differ in intensity, diversity of groups affected, and coincidence of first and last occurrences, probably reflecting different causes. Studies on the evolution of lineages are rendered more powerful by magnetostratigraphy: temporal control tests patterns of speciation, yields confident estimates on true temporal ranges of fossil taxa, and shows that rodent species longevities exceeded 2 m.y. on average.
Key words: Faunas, Miocene, Potwar, Siwaliks

F/147. Fontan, D., 1998. Regional geologic mapping, metamorphic P-T-t paths evaluations and ore potential assessment in Neelum Valley (Azad Kashmir, NE Pakistan). Ph.D. thesis, Univsite' de Louvain, 182p.

Key words: Metamorphism, geology, tectonics, economic geology, Neelum Valley, Azad Kashmir.

F/148. Fontan, D., Cosca, M.A., Schouppe, M., Gourirane, A., Hunziker, J.C., Kervyn, F., Martinotti, G. & Verkaeren, J., 1995. Geology and Tectonometamorphic Evolution of Neelum Valley (Azad Kashmir, NE Pakistan). Abstract Volume, 10th Himalaya-Karakoram-Tibet Workshop, (ETH Zurich) Switzerland.

This study is focused on the stratigraphy and the tectono-metamorphic history of the Higher Himalayan Crystalline (HHC) and the Lower Himalayan Crystalline (LHC) in the Neelum Valley. Over 20 samples of phengite white mica, biotite and phlogopite have been analysed by the 40Ar/39Ar method and help to constrain the tectonothermal history of the Neelum area.
The HHC and the LHC units have the same stratigraphic features. In both we have distinguished a cover overlying a basement. The basement is composed of an older granulitic complex stratigraphically overlain by a thick metasedimentary sequence; both are intruded by later granites. The granulitic complex mainly

consists of medium grained biotite, garnet-bearing gneisses with interlayers of amphibolite, interpreted as very old (Precambrian?) basic dykes. In accordance with Pognante & Lombardo (1989) we have distinguished between the basic dykes of type A, which are intruded only in the granulites (they are cross-cut by pegmatites referred to granites), and those of type B, which cross-cut the basement/cover regional banding and can be correlated with the Permian Panjal Traps. Acid granulites can presumably be correlated with the lskere Gneiss of Zeitler et al. (1989). The metasedimentary sequence (Salkhala Series) is represented by a thick flysch-like sequence that can be correlated with the Precambrian Hazara slate (Wadia, 1934; Wadia, 1952; Greco, 1989). The granites have been considered equivalent to the Mansehra Granite (516 ± 16 Ma, Le Fort et al., 1980) and to the Shengul Gneiss in the Nanga Parbat area (400 to 500 Ma, Zeitler et al. 1989), situated north of our area.

The cover (Upper Carboniferous ? - Jurassic?) uncomformably overlies the basement and can be correlated with the Kaghan Burawai Fm. of Greco et al. (1989) and with the First and Second cover of Spencer (1993). We have distinguished, from the bottom to the top, a siliceous, a carbonatic and a pelitic units.

In the Salkhala Series, old andalusite blasts (now pseudomorphosed by white mica) have grown on an older foliation have been interpreted as relics of pre-Himalayan tectono-metamorphic events. The foliation was probably formed during the Hazaran orogenesis (Baig and Lawrence, 1987) while andalusite blast are related to intrusion of Mansehra-type granitoids.

The rocks forming the basement and the cover have been deformed and metamorphosed during the Himalayan Tertiary events. The HHC and LHC tectonic units are characterised by a metamorphic zoning: in the HHC unit the metamorphic grade increases toward NE from upper greenschist facies to kyanite and sillimanite amphibolite facies and in the LHC unit the metamorphic grade ranges from greenschist to lower amphibolite facies.

The Tertiary metamorphism can be divided into three thermobarometric stages: an early stage of high pressure conditions, well preserved in the basic rocks outcropping in the medium grade terrains, characterised by omphacite + garnet, with estimated temperature and pressure of 600 ± 50CC and 15-18 Kbar (Gourirane, 1993), and by muscovite-bearing pegmatitealhat give upper Cretaceous 40Ar/39Ar cooling ages. Analogous thermobarometric results and an Eocene age have been found in the adjacent Kaghan valley (Pognante & Spencer, 1991; Villa et al., 1992; Spencer, 1993).

The second stage is a Barrovian prograde sequence defining the main rock fabric. The metamorphic grade ranges from greenschist to upper amphibolite facies and is the result of the decompression coupled with increasing temperature. The greenschist event is responsible for the formation of biotite and garnet while the amphibolite facies event formed typical garnet, biotite, kyanite and staurolite assemblages. With the increasing temperature kyanite and staurolite are replaced by sillimanite and garnet and in the Palaeozoic granites incipient melting is visible along narrow shear zones.

40Ar/39Ar cooling ages of muscovite and biotite yield middle Oligocene ages for the greenschist facies rocks and upper Oligocene to Lower Miocene cooling ages for the amphibolitic assemblages.

The third stage is characterised by further increasing temperature and drop pressure. It is responsible of formation of post-cinematic biotite in the greenschist facies rocks and coronitic rim (garnet around biotite) in the amphibolite terrain.

The structure of the basement and cover rocks of the Neelum Valley record the ductile nature of complex Himalayan deformation. Four successive phases of folding have been distinguished in the field.

A widespread penetrative schistosity (S1) associated with isoclinal folding (Fl) is constrained by 40Ar/39Ar analyses on white mica present in shear zones as upper Eocene. A second isoclinal and asymmetrical phase (F2), associated with 100 meters wide shear zones north dipping is coeval with movement along the Main Central Thrust (MCT). This thrust crosscuts the previous mylonites as well as the isograds. 40Ar/39Ar data on these mylonites give a Middle Oligocene (≈ 30 Ma) ages. Later, a third phase developed a crenulation cleavage (53) while the fourth folding phase produced open folds with a wavelength of several kilometres (F4).

Key words: Tectonics, metamorphism, Neelum valley, Azad Kashmir

F/149. Fontan, D. & Schouppe, M., 1994. Contribution to the Geology of Azad Kashmir (NE Pakistan): Mapping of the Neelum valley, recent geological results. Journal of Nepal Geological Society 10 (Abstract Volume, 9th Himalaya-Karakoram-Tibet Workshop, Kathmandu, Nepal), 42-44.

Because of its central position between the Hazara Kashmir Syntaxis (HKS) and the Nanga Parbat Syntaxis (NPS), the Neelum Valley represents a very attractive section through the major tectonic elements of the Western Himalayan mountain belt.
From 1991 to 1993, the NW flank of Neelum Valley has been systematically mapped at the scale 1:50,000 (from Tithwal to Kel: ±1500 km2). From the HKS to the higher structural levels, we have distinguished three units separated by two main thrust faults. We have found successively the Sub Himalaya (SH) inside the HKS, the Main Boundary Thrust (MBT) near Nauseri, the Lesser Himalaya (LH) up to Luat, the Main Central Thrust (MCT) crossing Man Nala, Jagran Nala and Ghurial Nala, and further north, the Higher Himalaya (HH).
The 1993 fieldwork has made it possible to locate a very good pretender to be the MCT connection between the MCT identified near Batal in the Kaghan Valley by Ghazanfar and Chaudhry (1985), near Musa Gali by Greco (1989), and near Luat in the Neelum Valley (Ghazanfar, Baig and Chaudhry, 1984). The newly detected MCT portion is recognized on the field by a >100 in thick shear zone expressed by dark mylonites in the schists and by light schistose mylonites in the granites. From place to place, rocks close to the MCT enclose numerous traces of metasomatism (scheelite bearing skarns). In Neelum Valley, the MCT, which demarcates the LH from the HH, crosscuts a single stratigraphic sequence. Consequently, the HH and the LH units do show the same stratigraphic features.
The pre-Himalayan basement comprises an older migmatite complex (embrekites, agmatites, anatexites) unconformably overlain by a thick meta-sedimentary sequence (the Precambrian Salkhala series of Wadia, 1934). The metasediments consist of psammitic to pelitic schists, in alternance with minor intercalations of impure marbles. Both formation are intruded by later granitoids, presumably of the early Palaeozoic age (Manshera-type of granite of Le Fort, 1988). The Himalayan cover (Upper Carboniferous-Jurassic?) lies unconformably on the basement. From bottom to top, it mainly includes gneisses and micaschists (Unit A), marbles, amphibolites, and calcschists (Unit B) and garnet micaschists (Unit C).
In Neelum Valley, the prevalent Himalayan metamorphic zoning ranges from lower to upper greenschist facies to kyanite and sillimanite amphibolite facies. The metamorphic grade increases towards NE.
Data collected in Neelum Valley suggest the following succession of geological events:
A very old metamorphism associated to an early Proterozoic orogenic event (1900-1800 My) generated the migmatite complex of the Pre-Himalayan basement. The metasedimentary Salkhala series was deposited subsequently unconformably on the migmatites. The leucogranite (Manshera type) intruded the whole basement (miginatites+Salkhala series). After uplift and erosion of the basement, the deposition of the Himalayan cover started in the region (Upper Carboniferous?-Jurassic?).
Later (About 250-300 My), basic dykes were emplaced through the whole cover-basement sequence.
The Himalayan deformation and metamorphism affected the basement and the cover.
Two subparallel penetrative schistosities Si and S1-2 were elaborated during the transposition of the basement-cover sequence and during the development of the MCT. The MCT brought to the north the LH as a hanging wall over the HH. This step marks the peak of the Himalayan deformation. A Barrovian-type stage of the Himalayan metamorphism follows an early stage in high-pressure conditions (eclogites discovered in Gumot Nala). Further strain generated tight to open folds (wavelength <1-km) associated with a crenulation cleavage S3. It was followed by a third stage of Himalayan retrometamorphism (growth of post-kinematic chlorite basalts). The next phase, characterised by regional open folds with a wavelength of several kin, disturbed regionally the geometry of all the previous structures. Brittle deformation started with a set of N500E trending subvertical faults.
Finally, late deformations, including kinks, fracture sets and subhorizontal local thrust planes, affected particularly the HH. The scientific and technical collaboration of J. Verkaeren and D. Daduron (Université Catholique de Louvain), G. Martinotti (Universita di Torino), R. Malik and his collaborators (Azad Kashmir and Industrial Development Corporation), during this work (EEC Grant No C11-0571-M (GDF) is gratefully acknowledged.
Key words: Mapping, Neelum valley.

F/150. Fontan, D., Schouppe, M., Hunziker, C.J., Martinotti, G. & Verkaeren, J., 2000. Metamorphic evolution, ^{40}Ar-^{39}Ar chronology and tectonic model for the Neelum valley, Azad Kashmir, NE Pakistan. 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, 431-453.

This paper describes the geology, tectonometamorphic history and geochronology of part of the northern flank of the Neelum Valley in Azad Kashmir, NE Pakistan. Metamorphic crystalline rocks in this area belong to the Lesser and Higher Himalayan Crystalline complexes. Geological mapping of about 1500 km2 confirms the presence of three main tectonic units characterized by similar lithostratigraphic sequences but with different tectonometamorphic histories. Whether these tectonic units belong to the Lesser or Higher Himalayan Crystalline depends on the, still controversial, position of the Main Central Thrust. A tectonic model, involving syn-convergent exhumation, is suggested that is consistent with new petrographic and geochronological data, and with a revised interpretation of the Main Central Thrust.
Key words: Metamorphism, geochronology, tectonic model, Neelum Valley, Azad Kashmir.

F/151. Forcella, F., 1978. Short notes on Trich Mir geology (Hindu Kush Range). Rend. Academia Nazionale dei Lincei 65, 307-312.

Key words: Geology, Tirich Mir, Chitral.

F/152. Foster, D.A., Gleadow, A.J.W. & Mortimer, G., 1994. Rapid Pliocene exhumation in the Karakoram (Pakistan), revealed by fission-track thermochronology of the K2 gneiss. Geology 22, 19-22.

Rapid Pliocene denudation in the Karakoram, Pakistan, as revealed by fission- track dating of rocks from K2 (Godwin Austen) was probably caused by tectonic uplift. Apatite separated from samples collected from elevations of 5300 to 8611 yielded fission-track ages of 2.1 ±0.6 to 4.3 ±1.4 Ma, and suggest an initial, apparent denudation rate of 3-6 mm/yr commencing after 5 Ma. One zircon separate from 6600 m gave a mean fission-track age of 32 ±6 Ma. The mid- Tertiary zircon age delimits the maximum amount of Pliocene denudation to ≤7000 m. The total amount of denudation at the present mean surface elevation of 6000 m was estimated to be 6000 m.
Key words: Exhumation, fission track, chronology, K2, Karakoram.

F/153. Foster, G., Kinny, P., Vance, D., Harris, N., Argles, T. & Whittington, A., 1999. The Pre -Tertiary metamorphic history of the Nanga Parbat Haramosh Massif, Pakistan Himalaya. Terra Nostra 99 (Abstract Volume, 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany), 44-45.

It is often assumed that within active orogenic zones, such as the Himalaya, metamorphic and tectonic fabrics exposed at the surface today relate to the most recent phase of orogenesis. However, for collision-related orogenesis this assumption is only valid for metasedimentary lithologies deposited immediately prior to the most recent event, e.g. sediments deposited on the continental margin of the now-closed ocean basin. The basement rocks on which these sediments were deposited, are almost inevitably polymetamorphic, and tight chronological controls on their thermal and deformation histories are required to avoid erroneous tectonic interpretations. The Nanga Parbat-Haramosh-Massif (NPHM), a basement terrain exposed by recent exhumation of the western Himalaya, is unique in the orogen in that it has experienced recent (2-10 Ma) and rapid (approaching 4 mm/yr.) exhumation with associated decompressive melting and leucogranite intrusion (Zeitler et al. 1993; Whittington, 1996). Approximately 90% of the rock exposed within the massif has been termed “basement” on the basis of zircon chronometry (Zeitler et al., 1989) and textural investigations (Wheeler et al., 1995), yet, due to the difficulty of unravelling polymetamorphic terrains, the Pre-Tertiary metamorphic history of the massif has yet to be established. Therefore, the true thermal significance of both the Himalayan (Foster et al., 1998) and the Neogene (Smith et al., 1992) metamorphic events cannot be accurately assessed until the pre-Himalayan fabrics and assemblages can be identified. Here we present the results of a systematic investigation into the thermal history of the basement rocks of the NPHM and draw important conclusions upon the nature of Pre-Tertiary events that affected this segment of the Himalayan orogen.

Our approach has been to combine detailed field and fabric studies with a range of chronometric approaches that include: (i) U-Pb SHRIMP chronometry of basic dykes that clearly cross cut migmatitic fabrics within basement gneisses; (ii) U-in-Pb SHRIMP analyses ci monazites within granitic bodies; (iii) Sm-Nd garnet analyses of metamorphic assemblages coupled with a thermobarometric treatment of these assemblages; (iv) Sm-Nd whole rock analysis of critical lithologies. As a result of these investigations we are able to recognise the following chronologies within the basement lithologies of NPHIM:

lskere Gneiss (Madin, 1986). This unit is exposed generally on the western and central portions of the massif and has a source age of around 2.5 Ga (Nd model age) and e(Nd) of around -18 to -27 (Whittington et al., 1999). Migmatisation occurred at 1852 ± 14 Ma (Zeitler et al. 1989), closely followed by basic dyke intrusion at 1824 ± 14 Ma as identified by the age of zircon cores within the dykes. Field relations suggest that in some cases, this intrusion occurred while the surrounding gneiss were still hot. A Sm-Nd whole rock-garnet investigation and further concordant zircon analyses also indicate a significant reactivation of this gneiss at around 1300-1000 Ma.

Shengus Gneiss (Madin, 1986). This unit is exposed generally in the eastern portions of the massif and has a similar source age (~2.7 Ga; Nd model age) to the Iskere Gneiss with inherited zircons of around 2.5 Ga (Zeitler et al., 1989). Intruding the metasediments of the Shengus Gneiss along the western margin (Schneider, pers. comm.), in the north along the Indus gorge (Zeitler et al., 1989) and on the eastern margin (this study), are 500 Ma granitic bodies. Of particular importance is a megacrystic intrusion along the eastern margin. Here field investigations and Th-Ph ages ci concordant monazites indicate this body was intruded at 467 ± 6 Ma, around 40 Ma after the main intrusive phase, thus suggesting correlation with the Manshera granite dated at 468 ± 12 Ma (Zeitler et al., 1989).

Based on the above data it is clear that these two components of the Nanga Parbat Haramosh massif are geologically distinct. What is not clear however, is how (if at all) they correlate with the well-documented terranes of the main Himalayan orogen. It is often assumed that the majority of fabrics and assemblages exhibited by the gneisses of the NPHM formed during the recent syntaxis-related metamorphic event. However, this has been shown not to be the case for the garnet-grade cover sediments exposed along the margins of the massif (Foster et al., 1998) and the data presented here suggest that pre-Himalayan fabrics and assemblages are also present in the basement lithologies. Our results not only document the resilient nature of the ancient continental crust but also illustrates the necessity of a systematic and chronologically well constrained approach to the study of polymetamorphic terrains.

Key words: Metamorphic history, NPHM, Himalaya

F/154. Foster, G., Vance, D. & Harris, N., 1998. The prograde thermal history of the Nanga Parbat Haramosh Massif, Pakistan. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop, 64-65.

The Nanga Parbat Haramosh Massif, in Pakistan, is unique in the Himalaya in that it has experienced recent and rapid exhumation (approaching 4 mm/yr.; Whittington, 1996) with associated decompressive melting and leucogranite intrusion (Zeitler et al., 1993). Zircon rims and monazites recovered from high-grade basement gneisses have yielded young ages which have been interpreted by some workers (e.g. Smith et al., 1992) to indicate that a Neogene partial melting event was also related to this rapid uplift. However, it remains to be established whether the entire massif underwent this event, and whether there is any part that preserves the earlier metamorphic history of this polymetamorphic terrane. The discovery of relatively low-grade metasediments along the margins, in particular in the south-eastern corner of the massif, allows an investigation of this problem. The best exposure of these rocks occurs in the lower Rupal valley where they form a sequence of kyanite + staurolite + garnet mica schists with associated garnet amphibolites and calcsilicates. Nd model ages and E (Nd) values of these and other such metasediments cluster around 1.8 Ga and-14 respectively, allowing them to be correlated with the High Himalayan crystalline unit exposed elsewhere in the central Himalaya rather than with the basement gneisses of the massif, which are more readily correlated with the Lesser Himalayan Unit (Whittington et al., this volume). Here we present new garnet-whole rock Sm-Nd ages for these rocks and show that they experienced garnet - grade metamorphism at about 20-50 Ma. These data, together with P-T determinations, demonstrate that the assemblage has followed a "prograde" Himalayan P-T-t path significantly predating the recent exhumation-related event. This study illustrates the power of garnet Sm-Nd chronometry to see through late stage overprinting events, and the importance of a systematic approach to the study of polymetamorphic terranes.

Key words: Mountain Building, NPHM, Himalaya.

F/155. Fox, C.S., 1923. The bauxite and aluminous laterite occurrences of India. Geological Survey of India, Memoir 49, 287p.

Key words: Bauxite, Aluminous Laterite, India.

F/156. Fox, C.S., 1926a. Water supply near Landi Khana. Geological Survey of India, Record 59, p.64.

This report concerns the supply of water to Landi Khana on the Peshawar- Torkham (Khyber Agency) railway line (the Khyber Railway).
Key words: Water, Landi Khana, Khyber Agency.

F/157. Fox, C.S., 1926b. Geological consideration which appear to affect the safety of Khyber Railway. North-Western Railway Press publication, Lahore.

This report concerns the geological consideration for the safety and sustainability of the Khyber Railway. The rail tracks pass through a gently sloping level ground up to Jamrud, from where on there is a steady climb up to Landikotal, followed northward by a steep descent to Torkham on the Pak-Afghan border. There are several bends and tunnels on the way between Jamrud and Landikotal. The track passes through sedimentary rocks, comprising mostly slates, phyllites and limestones.
Key words: Geological safety, Khyber Railway.

F/158. Fox, C.S., 1944. India's mineral resources for war and the future, (Presidential address), Quarterly Journal of the Geology, Mining and Metallurgy Society of India, 16, 93-106.

This is a summarized compilation of the mineral resources of the subcontinental India, known by 1943, for use in war and sustainable development.
Key words: Mineral resources, war, India

F/159. Fox, C.S., 1950. The mineral resources of Kashmir. Mineralogical Magazine 23/83, 80-86.

Key words: Mineral resources, Kashmir.

F/160. Fox, C.S. et al., 1942. The mineral wealth of India. Geological Survey of India, Record 76.

This document gives a review of the then known mineral deposits of India, including the present day Pakistan.
Key words: Mineral deposits, India.

F/161. Fernandez Polo, J.A., 1970. Caracteres de algunas yacimientos uranifieros del Pakistan. Energia Nuclear, Madrid, 14, 19-29.

This account gives some details of uraniferous deposits of Pakistan. It contains nine figures and one map.
Key words: Radioactivity, nuclear energy.

F/162. Francis, M.R., Miller, K.J. & Dong, Zhi-Bin, 1984. Impulse rader ice-depth sounding of the Ghulkin Glacier. In: Miller, K. J. (Ed.). The International Karakoram Project 2, 111-123. 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, Ghulkin, Hunza.

F/163. Fraser, H., 1998. Structural and metamorphic evolution of the deep crust in the Hunza Karakoram, Pakistan. Geological Bulletin, University of Peshawar 31 (Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop), p.65.

The Karakoram Metamorphic Complex forms the southern most margin of the Asian Plate with the northern limit of the complex in Hunza being marked by a tectonic contact with the Hunza Plutonic Unit. (Desio, 1964; and Crawford and Searle, 1993). This granodiorite is a pre-collisional batholith that exhibits a strong foliation at its southern contact with the underlying metamorphic rocks. The southern margin of the complex is marked by the Shyok Suture Zone as described by Pudsey, 1986.
A detailed map of the middle Hunza valley has been produced that illustrates the principal lithologies, structural features and locations where detailed petrology and thermobarometry has been carried out.
Rocks ranging from staurolite through kyanite to sillimanite grade occur in the middle Hunza valley and exhibit an inverted metamorphic sequence with structurally higher units exhibiting the highest metamorphic grade. This is reflected not only in the mineral assemblages present, as previously noted by Broughton et al., 1985, but also in pressure and temperature estimates throughout the slab, extending previous work carried out by Okrusch et al., 1976. This inversion appears to be a consequence of south directed ductile and semi-ductile shear and later brittle thrusting which emplaced higher grade units over those of lower grade in agreement with earlier work of Crawford and Searle, 1993. P-T work shows a small variation in values for staurolite grade rocks, but those of sillimanite grade rocks show greater variation in pressure estimates. Retrograde reaction textures have been observed in those sillimanite grade samples that have yielded lower pressures of 5.8+1.2 and 4.4+1 Kb. Temperatures are typically 628+41 to 674+49 C. These P-T patterns may reflect those seen in the Baltoro, reference Searle and Tirrul, 1991; Allen and Chamberlain, 1991; and Lemennicier et al., 1996.
Key words: Structure, metamorphic evolution, Hunza.

F/164. Fraser, J., Searle, M., Parrish, R. & Noble, S., 1999. U-Pb geochronology on the timing of metamorphism and magmatism in the Hunza Karakoram. Terra Nostra 99, Abstract Volume, 14th Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany, 45-46.

U-Pb dating has been carried out on samples of regional metamorphic rocks and granites of the Hunza Karakoram in northern Pakistan with the aim of deciphering the thermal and magmatic evolution of the thickened Asian plate crust. The pre-collisional (India-Asia collision) origin of the Hunza plutonic unit granodiorites forming the main component of the Karakoram batholith in this part of the range has been confirmed by three concordant zircon analyses yielding a U-Pb crystallisation age of 105.7 ± 0.5 Ma. The Hunza dykes consist of a co-genetic suite of granodiorites, monzogranites and leucogranites, which intrude the early phase of the batholith, as the sillimanite grade rocks to the south. Zircon and uraninite from the early set of Hunza dykes parallel to the regional north-dipping schistosity have concordant U-Pb age of 51.5 ± 1.5 Ma.
One sample of a garnet + biotite leucogranite dyke from the later set of Hunza dykes which emmanate from the southern part of the granite batholith and cross-cut sillimanite gneisses and phlogopite ± ruby corundum marbles, has been dated using zircon, monazite and uraninite at 35.1 ± 0.6 Ma, similar to the age of the Mango Gusar pluton (37.0 ± 0.8 Ma; U-Pb on zircon), south of the Baltoro plutonic unit to the east. Monazites from a sillimanite grade meta-pelite from Baltit gave a U-Pb age of 68 ± 0.5 Ma, which is

interpreted as the timing of sillimanite grade peak metamorphism and deformation in the Karakoram metamorphic complex south of the Karakoram batholith. Sillimanite grade metamorphic rocks in the Hunza valley structurally overlie kyanite and staurolite grade rocks which have been emplaced southwards over low-grade rocks of the Shyok suture zone forming an inverted metamorphic field gradient. Monazites were separated from these highly graphitic garnet-staurolite schists and yield an interpreted crystallisation age of 16.0 ±1.0 Ma. The somewhat large error ellipses are due to the numerous inclusions in these monazites. All presently available U-Pb geochronological data from the Hunza and Baltoro Karakoram suggest that two metamorphic episodes are present: (1) a long-lasting latest Cretaceous to late Eocene sillimanite grade event south of the batholith in Hunza and (2) a mid- to late Miocene ~16 Ma staurolite -kyanite grade event along the southern part of the metamorphic complex. The youngest phase of crustal melting is dated at 9.2 ± 0.5 Ma from U-Pb ages ci zircon, xenotime and uraninite from the Sumayar tourmaline leucogranite south of the Karakoram batholith.

Key words: Geochronology, metamorphism, magmatism, Hunza, Karakoram.

F/165. Fraser, J., Searle, M. Parrish, R.M. Noble, S. & Thimm, K., 1998. U-Pb geochronology on the timing of metamorphism and magmatism in the Hunza Karakoram. Geological Bulletin, University of Peshawar 31, Abstract Volume, 13th Himalayan-Karakoram-Tibet International Workshop, 66-67.

U-Pb dating has been carried out on samples from the regional metamorphic rocks and leucogranites of the Hunza Karakoram with the aim of deciphering the thermal and magmatic evolution of the thickened Asian plate crust. The pre-collisional origin of the Hunza plutonic unit granodiorites forming the main component of the Karakoram batholith in this part of the range has been confirmed by three concordant zircon analyses yielding a U-Pb crystallisation age of 105.7±0.5 Ma (sample K94-24). The Hunza dykes consist of a co-genetic suite of granodiorites, monzogranites and leucogranites, which intrude the early phase of the batholith, as well as the sillimanite grade rocks to the south. One sample (K 94-23) of a garnet+biotite leucogranite dyke emanating from the southern part of the granite batholith and cross-cutting sillimanite gneisses and phlogopite±ruby corundum marbles, has been dated using zircon, monazite and uraninite at 35.3±0.4 Ma, similar to the age of the Mango Cusar pluton south of the Baltoro plutonic unit to the east (37.0+-0.8 Ma, U-Pb on zircon; R.Parrish data in [11. These two ages put an upper time constraint on sillimanite grade peak metamorphism and deformation in the Karakoram metamorphic complex south of the Karakoram batholith.

The Sumayar leucogranite is a small isolated tourmaline leucogranite with minor biotite and garnet intruding staurolite grade schists south of the Karakoram batholith in the Nagar region east of Hunza. It is a water-saturated, minimum-melt leucogranite similar to many High Himalayan granites, probably derived from melting of a pelitic lower crustal source [21. U-Pb dating of zircon and uraninite yields an age of 9.2±0.1 Ma, whereas xenotime intergrown with zircon yields 8.55±0.15 Ma. The apparently distinct ages of intergrown zircon and xenotime could be explained by two periods of mineral growth (and partial resorption?) or by Pb loss in xenotime. This shows that this is the youngest crustal melting event in the Karakoram, and it cannot therefore be linked temporally to the Mango Cusar or Chingkiang-Ia plutons, south of the Baltoro granite, as previously thought. Several phases of granitic dyke intrusion are present in the Hunza section and dykes emmanating from the Sumayar pluton must be a younger phase than the Hunza dykes.

Metamorphic monazites were extracted from a staurolite+garnet mica schist (K94-20) from Nasirabad in the Hunza valley. The 206Pb/23SU age of monazite is 15.5-16.5 Ma and due to probable excess 206Pb, we interpret the crystallization age as 14-16 Ma. This must date the timing of monazite growth during staurolite-grade metamorphism, and is considerably younger than the previous estimates of a pre-37 Ma age for metamorphism of all the southern Karakoram metamorphic complex [3]. All presently available U-Pb geochronology from the Hunza and Baltoro Karakoram suggest that two metamorphic episodes are present: (1) a pre-37 Ma late Eocene-Oligocene sillimanite grade event south of the batholith in Hunza and the Baltoro region, and (2) a mid- to late Miocene ~16 Ma staurolite - kyanite grade event along the southern part of the metamorphic complex.

Key words: Geochronology, metamorphism, magmatism, Hunza, Karakoram.

F/166. Friend, P.F. & Raza, S.M., 1991. Size and form of the fluvial sandstone bodies of the Lower Chinji Formation (Miocene, Siwalik Group), Northern Pakistan. Abstract Symposium on Characterization of Fluvial and Aeolian Reservoirs, Aberdeen University, Scotland.

Key words: Sandstone, Siwaliks, Chinji Formation, Miocene.

F/167. Friend, P.F., Raza, S.M., Baig, M.A.S. & Khan, I.A., 1994. Geological Evidence of the ancestral Indus from the Himalayan Foothills. In: Meadows, A. & Meadows, P., (Eds.), The Indus River, Biodiversity, Resources, Humankind. Linnean Society, Symposium on the River Indus. Proceedings, Burlington House, London, Oxford University Press 103-113.

Northern Pakistan contains classic outcrops of Himalaya-derived 'Siwalik' river sediments, rich in mammal fossils, and dating from between twenty million years ago and the present. The sediment logical analysis of local structures in these sediments has made it possible to reconstruct the flow directions of the depositing rivers. In outcrops west of the present Indus, the depositing rivers are seen to have flowed with Indus-like trend, towards the south. East of the present Indus they are seen to have flowed with a more Ganga-like trend, towards the south-east and east. The Sargodha 'high' of basement outcrops may represent a structure that caused the divergence between these two trends. From about eight million years ago, there is evidence that a particularly large river emerged from the mountain front in approximately the position of the present Indus, and this is identified as the ancestral Indus.
Key words: Geology, Siwaliks, Indus, Himalayan.

F/168. Friend, P.F., Raza, S.M., Geehan, G. & Sheikh, K.A., 2000. Intermediate-scale architectural features of the fluvial Chinji Formation (Miocene), Siwalik Group, northern Pakistan.

The Lower Siwalik, Chinji Formation (Late Miocene) of the Chinji Village area, northern Pakistan has provided remarkable material for the study of terrestrial fossil faunas, magnetic reversal stratigraphy and fluvial sedimentology. This paper considers patterns in the sedimentary stratigraphy, using magnetic reversals to constrain the time framework, and focusing on an intermediate (kilometre) horizontal length-scale. The project aimed to determine the architecture and time relationships of the channel sandstone bodies in a panel 300 m in stratigraphic thickness, and 11 km in horizontal length (along stratigraphic strike). This panel (the 1990 Fence) trends at a high angle to the flow direction of the Late Miocene river channels, and represents about 2 Ma of sediment accumulation. There is a continuous range in thickness of the sandstone bodies, but they can be usefully classified into (i) microbodies, (ii) minor sheets, (iii) thin mega-sheets and (iv) thick mega-sheets. The microbodies are probably mainly marginal features of the thicker bodies. The minor sheets were formed by small river channels, and the mega-sheets were formed as the deposits of the largest, generally braided, channel belts. Two aspects of the intermediate length-scale architecture of the Chinji Formation are analysed: (1) the presence in the Fence of three thick mega-sheets separated by two mudstone-dominated intervals that lasted for about 0.5 and 1.0 Ma, respectively and (2) the abrupt upwards increase in sandstone/mudstone proportions that defines the upper stratigraphic boundary of the Chinji Formation. We suggest that each of the three thick mega-sheet episodes resulted from avulsions into the area of large-channel belt complexes that formed central features of the Chinji river network and were each constrained by scarps or valley-side slopes during episodes of net deposition that lasted for about 100 ka, and may have resulted from climate and/or sea-level changes. The regional upward change from mudstone- to sandstone-domination at the top of the Chinji Formation resulted from a similar, but one-off, and more widespread, change in plan-view style of the river network, produced either by tectonic change in the mountain source area, or by climatic change.
Key words: Stratigraphy, fossils, Chinji Formation, Siwaliks.

F/169. Fuchs, G., 1970. The significance of Hazara to Himalayan geology. Geological Bundes. Jahrd. Sondubd 15, 21-23.

Key words: Hazara, Himalaya.

F/170. Fuchs, G., 1975. Contribution to the geology of the north western Himalayas. Geologische Abhandulungen 32, 1-59.

Key words: Geology, Himalaya.

F/171. Fuchs, G., 1999. The evolution of the Himalayan orogenesis. Terra Nostra 99, Abstract Volume, 14^{th} Himalaya-Karakoram-Tibet Workshop, Kloster Ettal, Germany, 47-48.

Orogenesis is a complex process involving tectonics, sedimentation, magmatism, metamorphism etc. Many problems arise: When did orogenesis start; how did tectonisation propagate; what happened in different tectonic zones contemporaneously? We must come to a vivid picture of the growth of the mountain chain. I am giving such a picture-admittedly subjective and the number of aspects is certainly not complete-but I hope that it will invite discussion.

Research of the last two decades has shown that the orogenesis started already in the Maastrichtian: The blockflysch of the Tsangpo region (Burg, 1983) is an orogenic sediment formation, which documents that the northern margin of India was already close to the subduction zone. Overlap of the Lamayuru basin facies onto the Zanskar Shelf followed by folding of the Tethyan Zone indicates a short period of down bending in the Maastrichtian when the continental margin reached the subduction zone and collided with the Asian Plate (Fuchs, 1982). The overlapping euxinic sediments, however, are connected with the underlying Campanian Fotu La Formation and do not represent an early thrust sheet as proposed by Corfield et al. (1996). In Pakistan, Beck (1995) found Upper Paleocene beds transgressing the accretional wedge of the MMT.

This early collision of India was not with the Asian Continent but with trapped oceanic lithosphere of the Asian Plate (Dürr 1995; Fuchs and Linner 1996). The latter was consumed in the course of continued convergence in Maastrichtian-Early Eocene times along a second melange zone north of it.

Connections between Asia and India, as early as at the Cretaceous/Tertiary boundary, are also documented by floral and faunal exchange (Prasad et al., 1988; Jaeger et al., 1989). Palaeomagnetic research also suggests that collision occurred around the Cretaceous/Tertiary boundary in equatorial latitudes (Klootwijk et al., 1991) and that the extended northern margin of India reached the subduction zone earlier than assumed previously (Appel, 1989; Patzelt, 1996).

Thus pre-Eocene collisions are well-documented. The continent/continent collision along the whole suture, however, occurred in the Early Eocene. Then the MMT was sealed in Pakistan (Beck, 1995) and the Spontang thrust mass was emplaced on the Zanskar Shelf (Fuchs, 1982; Fuchs and Willems, 1990). That event put an end to the marine sedimentation and initiated the deposition of terrestrial molasse along the Indus-Tsangpo Suture Zone. Compressional phases with uplift and denudation alternated with extensional phases and molasse transgression. Rather late ultrabasic masses came to rest on the molasse, which was folded and imbricated with the underlying beds. It seems that the Miocene nappe tectonics in the southern Himalaya coincide with extensional tectonics in the north.

The Miocene age of the Lesser Himalayan nappe stacking is proved by the Dagshai Formation exposed in windows, the cooling ages of the Crystalline nappes and the start of Siwalik sedimentation in the foredeep. Later the Lesser Himalayan nappe pile was folded, which led to windows and outliers. The scene of thrusting shifted further south to the MBT. Siwalik sedimentation was accompanied by the formation of new thrusts, which became younger southwards (Herail et al. 1986).

In the Lesser Himalaya a mature relief was formed by denudation. Quaternary reactivation of older lineaments led to the steep southern flanks of the Great Himalaya, Panjal, Dhauldhar and Machabhewat Ranges. This does not mean that the MCT is a young thrust, as suspected by Raiverman (1997).

Latest molasse deposits in the Tethyan Zone (Plio-Pleistocene) are non-folded but disturbed by faulting and tilting during the uplift of the Great Himalayan Range (e.g. Sutlej, Takkhola).
The above is a rough picture of the complex orogenic development commencing along the suture, propagating towards the south and thus involving more and more rock series of the Indian passive margin. This process spans a period of approximately 70 m.y. and has not yet ended.
Key words: Tectonics, orogeny, Himalayan.

F/172. Fuchs, G. & Gupta, V.J., 1979. The significance of the Tanol Formation of the western Himalaya. In: Gupta, V.P. (Ed.), Contribution to Himalayan Geology, Upper Paleozoics of the Himalaya 1, 154-161.

Key words: Tanol Formation, Himalaya.

F/173. Fuchs, G. & Mostler, H., 1972. Der erste Nachweis von fossilien (Kambrischen Alters) in der Hazira-Formation, Hazara, Pakistan. Geologische Palaontolgische, Mitteilungen (Innsbruck) 2, 1-12.

Within the marly respectively calcareous dolomitic beds of the Hazira Formation there are sporadic phosphate airs rich in biogenic matter. Obviously they are replacement products, as all the organic remains are replaced by apatite.
The microfauna yielded by maceration indicates Cambrian age. The fossils cited below, according to present knowledge, point to Lower Cambrian age; porifera (Archiasterella pentactina SDZUY, Allonnia tripodophora DORE and REID and “stauractine” archiasters; Calyptoptomatids (Hyolithes EICHWALD and orthothecides) and forms of doubtful systhematic position (Hyolithellus EICHWALD). Further there are forms probably belonging to the annelids (? Lapworthella COBBOLD, ? Rushtonia COBBOLD and POCOCK).
Key words: Paleontology, Hazira Formation, Hazara.

F/174. Fujii, N., 1995. Genesis of clay deposits and their exploration: Focusing on some clay deposits in Pakistan. Proceedings of Geoscience Colloquium (Geoscience Lab, GSP, Islamabad) 12, 23-40.

This paper discusses the mineralogical and chemical aspects of clay minerals and their genesis. The shahdheri china clay deposits have been described. It is concluded that this deposit is rather low in content and contains Ca rich feldspar. Such a raw material might not be suitable for the common ceramic products.
Key words: Clay deposits, exploration.