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GEOCHEMISTRY OF THE GARAM CHASHMA METASEDIMENTS, CHITRAL, NORTH EN PAKISTAN.

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Abstract:- *The metasediments of Arkari Formation at Garam Chashma host the tungsten mineralisation in Chitral, northern Pakistan, within the Hindu Kush terrane. These metasediments are composed of garnet mica schist, phyllite, marble psammite, calc-silicate rocks, quartzites, and tourmalinites. The analysed rocks are intruded by leucogranite emplaced after the culmination of amphibolite facies metamorphism. These leucogranites are exposed 400 away from the scheelite mineralisation.*

The trace elements data of the background metasediments at Garam Chashma and surrounding areas indicate that these rocks have undergone a hydrothermal alteration. The higher levels of F, Li, Cs, and to a lesser extent Be, W, Pb, Th, Zr, Y, Hf and Nb are compatible to the metasomatic activity in the area. The source of the hydrothermal fluids appears to be related to the near by exposed leucogranite.

SYSTEMATIC PALEONTOLOGY AND MORPHOLOGICAL VARIATIONS IN NUMMULITES ASSEMBLAGE OF EOCENE CHORGALI FORMATION OF NURPUR AREA, SALT RANGE, PUNJAB, PAKISTAN.

BY

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Abstract: *The present studies were conducted for the identification of the fossil foraminifera collected from the Chorgali Formation exposed at Nurpur Area in the Salt Range. The Chorgali Formation represents the paleoenvironments before the deposition of the Kuldana Formation. The Chorgali Formation were deposited in marine water condition while Kuldana Formation was deposited mostly in fresh to brackish and occasionally shallow marine water condition.*

The larger foraminifera identified in the Chorgali Formation are mainly Nummulites. The detailed taxonomical studies of these larger foraminifera indicated the presence of two common species in the Chorgali Formation identified as Nummulites atacicus and Nummulites aff. globulus. Morphological variations in N. atacicus and N. globulus from a number of localities are documented here.

The Nummulites found in the Chorgali Formation lived in the clean, warm water during the deposition of the carbonates of the Chorgali Formation. These creatures vanished due to the transportation of the detritus in to the sea and changing the clean waters into the muddy dirty waters.

NIKANAI GHAR FAULT, SOUTH OF MAIN MANTLE THRUST, LOWER SWAT, NW HIMALAYA, PAKISTAN: AN EXAMPLE OF EXTENSION IN A COLLISIONAL MOUNTAIN BELT

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Abstract:- *Detailed transects across the lower Swat-Buner and Swabi areas in NW Himalaya has resulted in the recognition of E-W striking, steeply south dipping Nikanai Ghar Fault (NGF) . The NGF juxtaposed rocks of two different tectonostratigraphic terranes, the lower Swat terrane and the Swabi terrane. These terranes display marked contrast in their stratigraphy, igneous activity, tectonic style, and grades of metamorphism. Rocks in the footwall of the NGF (lower Swat terrane) are high grade (≈ 600° C) metamorphics that are juxtaposed against weakly metamorphosed sedimentary rocks (Swabi terrane). Some of the rocks of Swabi terrane contain conodonts that yield coloration indices corresponding to temperature no higher than 350°C. We interpret that NGF is a normal fault, and is a structure typical of regional extension (resulted due to gravity-controlled mechanism), although the lower Swat and Swabi terranes lie within a zone of regional shortening.*

ALKALI AGGREGATE REACTION (AAR) POTENTIAL OF MURREE SANDSTONE: IMPLICATIONS FOR MOLASSIC, LITHIC SANDSTONES OF COLLISIONAL OROGENIC BELTS

BY

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Abstract:- *Molassic Murree Formation of upper Eocene to Miocene age, derived from the Himalayan continental collisional belt is an important and persistent unit of Outer Himalayas of Azad Kashmir and Pakistan. It was deposited by a meandering river system and is predominantly composed of red shales/mudstones and grey to grayish red sandstones. The sandstones of this formation are fine to medium grained calcite cemented lithic arenites. The coarse grained lithic arenite are generally restricted to the channel bottoms. These lithic arenites are sub-angular to sub-rounded, compositionally immature and texturally sub-mature. The stable minerals/rock fragments are quartz, chert and quartzite. The unstable rock fragments include limestone, shale, slate, phyllite and merro-crystalline volcanics. The accessory minerals are muscovite, biotite, garnet, actinolite, hornblendite, zircon, chlorite, epidote, tourmaline and glauconite. Carbonate cement is predominant while silica and iron oxide cements are minor.*

The deleterious constituents with Alkali Aggregate Reaction potential are chert, shale, slate, phyllite and merro-crystalline acid volcanics. In scores of samples studied, the deleterious constituents generally exceed 6%. These sandstones are therefore invariably potentially reactive. Sandstone have a range of specific gravity 2.52 to 2.73, water absorption 0.40 to 1.85 %, flakiness index 6.3 to 18.5 %, elongation index 6.0 to 8.9 %, organic matter 0.30 to 0.49 %. Los Angeles uniformity of wear 0.16 to 0.23 % and sodium sulphate soundness 8.20 to 14.30 %.

GEOLOGY AND DEFORMATION IN LESSER HIMALAYAN SEDIMENTARIES, BAGNOTAR-BARAGALI SECTION DISTRICT ABBOTTABAD, NORTHWEST HIMALAYA, PAKISTAN

BY

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Abstract:- *Geology of Bagnotar area is comprised of Jurassic to Paleocene sedimentary sequence overlying low grade metamorphosed Precambrian turbidites. Structurally, the main fold axes trend NE-SW, the vergence being generally NW, south of the Nathia Gali Thrust between Tredha Gali/Kalabagh and N-S running Bara Oter segment of Dor River. Intraformational folding is mainly developed in the Hazara and Samana Suk formations. The area has suffered a polyphase deformation. The metamorphosed Precambrian Hazara Slate Formation represents the first phase of deformation. D1. The second phase, D2, is represented by the NE-SW trend of the major folds, folding and overturning the sequence to the southeast as well as leading to major southeast directed thrusting. Finally, relaxation led to normal faulting. The final D_3 phase of deformation is exhibited by the double plunging character of the main folds as well as by the numerous gentle flexures on the flanks of the major folds. This phase relates to the formation of the Hazara Kashmir Syntaxis.*

SERPENTINIZED PERIDOTITES FROM THE INDUS SUTURE OPHIOLITE IN SWAT, NW PAKISTAN: GEOCHEMISTRY AND PETROGENETIC IMPLICATIONS

BY

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Abstract:- *The ultramafic rucks and related lithologies of the Swat valley ophiolite occur as lenticular bodies distributed along the Main Mantle Thrust (MMT) between the Kohistan island arc and Indo-Pakistan plate. The majority of the ultramafic rocks consist of abundant, fine grained serpentine, subordinate amounts of invariablv bastitised, medium to coarse grained orthopyroxene, trace to accessory amounts of partly altered (zoned with ferritchromite and/or magnetite) chrome spinel, variable proportions of olivine, and accessory amounts of clinopyroxene. Thus the ultramafic rocks are dominantly harzburgitic in mineralogy and, therefore, the ophiolite as a whole can be classified as the harzburgite sub-type. The present petrographic characteristics and mineral-chemical composition of these rocks appear to be the result of a number of phenomena including alteration and metamorphism.*

Relict (unaltered) cores of the original chrome spinel grains and the occurrence of pyroxenes are the only primary mineralogical features of the studied ultramafic rocks. The former is Mg-[I00Mg/(Mg + F^2) = 50-60}, (Cr-rich [100Cr/(Cr + Al) = ~50-70]. TiO_2-poor, and has more or less uniformly low Fe^3 content. The clinopyroxene is highly magnesian [100Mg/(Mg + Fe^2) = ~90-98], contains relatively low amounts of Al (Al_2O_3 mostly <2.5 wt %) and Ti (TiO_2 <O.2 wt %), and display low Ca/Mg and Na/Ca ratios. These mineralogical features suggest that the major bulk of the studied ultramafic rocks originated as a residue of the upper mantle left after partial melting. Mineralogical comparison with residual rocks from other areas shows that, prior to emplacement during the Cretaceous-Tertiary collision between the Indo-Pakistan plate and the Kohistan arc along the MMT, the studied rocks had suffered an intermediate degree (> 15 to < 30 %) of partial melting.

PETROGRAPHY OF THE URANIFEROUS QUARTZOFELDSPATHIC VEINS AND THEIR WALL ROCK FROM MARGHAZAR, LOWER SWAT, P PAKISTAN

BY

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Abstract::- *The Lower Swat area consists of the Cambrian-Ordovician(?) Swat granite gneisses that have intruded the metasedimentary rocks of the Precambrian Manglaur Formation and are ? overlain unconformably by the Paleozoic-Mesozoic metasedimentary rocks of the Alpurai group. The Swat gneisses contain minor amounts younger tourmaline granite gneiss particularly at their margins. Besides, locally (e.g. in the Marghazar area) the Swat gneisses host several quartzo-feldspathic vein systems, some of which show anomalous radioactivity.*

The radioactive quartzo-feldspathic veins are mostly medium-grained, hypidioblastic to xenoblastic and almost equigranular. They consist of distinct layers, which are alternately dominated by quartz and feldspar. With the exception of the radioactive minerals, the mineralogical composition of the vein systems is almost similar to that of the wall rock. In the order of decreasing abundance, the vein minerals include quartz, alkali feldspar, plagioclase, radioactive minerals iron ore, epidote, muscovite, biotite and tourmaline. The vein systems are associated with typical wall rock alteration phenomena that include kaolinitization, chloritization, epidotization, sericitization, and haematitization. Reflected light study reveals that the radioactive minerals in the vein systems consist of pitchblende, uraninite and pyrochlore.

Filed observations and mineralogical and textural characteristics suggest that the vein systems and their associated radioactive element mineralization resulted from a hydrothermal activity. As the vein minerals themselves display preferred orientation, the hydrothermal activity probably took place during a major phase of deformation and as such the veins are syntectonic in origin. The source of the hydrothermal solutions, which formed the vein systems and the associated mineralization, seems to be the relatively young, syntectonic tourmaline granite that occurs at the margins of the Swat granite gneisses.

THE MICROFACIES AND DIAGENESIS OF THE KINGRIALI FORMATION, KALA CHITTA RANGE, PAKISTAN.

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Abstract:- *Microfacies analyses of the Kingriali Formation of four systematically measured sections from Chapra, Surg, Chak Jabbi and Sakhi Zinda Pir localities is presented for the first time from the Kala Chitta Range. The Kingriali Formation consists of limestones and dolomitic limestones. The cathodoluminescence study has revealed that dolomite crystals which under normal petrographic microscope appeared to be of the seme composition, are zoned and zones of at least three generations have been identified. The nature of dolomite crystals in the dolomitised parts of Kingriali Formation indicate varying nature of dolomitizing fluids. Secondary porosity due to dissolutions of dolomite crystals and enlarged fractures have been noticed under cathodoluminescence microscope. The different composition of various zones of zoned dolomite crystals have been confirmed by wavelength dispersive spectrometery.*

AN OVERVIEW: POLICIES, PRIVATIZATION & REGULATION OF PETROLEUM SECTOR

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ORIGIN AND DISTRIBUTION OF NITROGEN IN CENTRAL INDUS BASIN - PAKISTAN

BY

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Abstract:- *Central Indus Basin is the most prolific gas-producing basin in the sub-continent, and is unique in the sense that it has produced only dry gas with very little condensate. Eocene and Cretaceous rocks are the main reservoirs in this basin. More than 1 TCF of carbon dioxide (CO_2) and nitrogen (N_2) are estimated to be present as contaminants (N_2 being more than 50%) of total about 2 TCF gas reserves. The maximum concentration of N_2 is about 42 % at Badar -I. High CO_2 contents are sometimes accompanied with high N_2 (Khairpur-2 and Uch) but generally there is no obvious relationship between N_2 and CO_2 contents. High proportion of N_2 might have been contributed from thermal breakdown of urgent matter in late mature source rocks.*

The high accumulation of inerts has a great impact on the prospectivity and the economics of the discoveries. Contaminated reserves of more than 2 TCF have remained undeveloped since their discovery due to higher percentage of non-combustible gases associated with hydrocarbon gases. Exploration areas around such fields have been considered to carry high risk for exploratory drilling since it has been taken for granted that any gas discovery in such vicinities will also contain abundant inert gases and make any discovery in the area uneconomical. However, recent drilling in Block-22 (north of Jacobabad-Khairpur High) by Pakistan Petroleum Limited (PPL) and the data from offset wells suggest that the occurrence of these gases is not ubiquitous.

Present study denotes that the variation in the distribution of CO_2 and N_2 can be understood by relation their occurrence with various phases of source rock thermal maturity and migration into the reservoirs during different episodes of structuring. Deep-seated NNW-SSE faults in and around the structures are considered to be responsible for feeding non-hydrocarbon gases and hence their distribution may be predictable. This thesis also leads to infer that higher accumulations of inerts in one reservoir level may not be so in another reservoir level within same structure/field. Therefore, the areas previously assumed to be uneconomical due to .their proximity to gas fields contaminated with inerts may actually hold good quality gas.

TECTONIC EVOLUTION OF DARGAI ULTRAMAFIC-MAFIC COMPLEX, NORTHWEST HIMAL Y AS, PAKISTAN

BY

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Abstract:- *In the Himalayan collision zone of northern Pakistan, south of Indus suture zone, the Dargai complex is emplaced on the Paleozoic metamorphic cover sequence of the Indian plate. A schematic structural and tectonic evolution for the emplacement of Dargai complex is proposed here since Cretaceous. The Dargai ultramafic-mafic complex is considered as the klippe or ophiolitic melange of the Indus suture zone. Field observations support the interpretation that the Dargai complex is an alpine ophiolite. These include (a) lack of chilled margin, (b) absence of lamination in tectonite, (c) no intrusive contact, (d) mylonitized and brecciated fault contacts and (e) shows Himalayan metamorphism and deformation. It is a dismembered ophiolite sequence of forearch oceanic crust. It is proposed here that the Dargai klippe is the folded extension of the Main Mantle thrust (MMT). The trace of the MMT is the Behram Dheri thrust which has been eroded between Darga*i and Indus suture zone due to post-Eocene tectonic uplift and erosion of the Indian plate rocks.

CHEMICAL COMPOSITION OF ILLITE/SMECTITE FROM KARAK MUDSTONE, KOHAT PLATEAU, PAKISTAN.

BY

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Abstract:- *Karak mudstone is predominantly composed of mixed-layer illite-smectite. Expandable smectite layers varies between 20 to 30%. The content of fixed K per illite layer linearly varies with percentages of expandability and lies between 0.73 to 0.85 per* $O_{10}/O(OH)_2$ *for illite layers formed in R1 ordered illite-smectite. The exchangeable cations show linear relationship with expandability and high layer charge increases with decreasing smectite contents in mixed-layer illite/smectite.*