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PRESENCE OF MAIN CENTRAL THRUST IN THE TECTONIC DOMAIN OF NORTHWESTERN HIMALAYA IN PAKISTAN

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ABSTRACT

The tectonic model of the northwestern Himalaya remained obscure for years for lack of demarcation of the Indus Suture Zone (ISZ) and Main Central Thrust (MCT) which are the two important tectonic features of the rest of the Himalaya. The problem of the ISZ was solved about a decade ago by locating two suture zones, the Main Mantle Thrust (MMT) and the Main Karakoram Thrust (MKT) with an intervening Kohistan island arc (Tahirkheli et al., 1976, 1979). The location of MCT remained a debatable issue because of its discontinuity beyond west (Simla) Himalaya towards northwest in Kashmir and northern Pakistan. As a result, the Main Boundary Thrust and the Panjal Thrust in Kashmir and NW Himalaya, respectively, were considered as analogues of MCT.

This paper discusses a newly discovered deep level thrust named "Shontargali Thrust" which on the basis of geographic location and tectono-stratigraphic setup, compares favourably with the Main Central Thrust.

INTRODUCTION

The Main Central Thrust (Heim and Gansser, 1939) is an intracrustal thrust formed as a result of collision between the Indian and the Eurasian plates during Oligocene. This thrust has pushed a deep level of basement over the high-level metasedimentary sequence of the Lesser Himalaya.

The Main Central Thrust (MCT), located to the south of the Indus suture zone (ISZ), has been mapped uninterrupted between the Assam Himalaya in the east and the Simla Himalaya in the west. However, it loses its identity further west. To overcome this tectonic anomaly most of the Himalayan geologists (Gansser, 1976, 1980; Valdiya, 1979; Thakur, 1981, 1983; Sinha, 1987; Le Fort, 1986) considered the Main Boundary Thrust (MBT) and the Panjal Thrust (PT) to represent the subsurface extension of the MCT.

Studies undertaken by the author in Kashmir and NW Himalaya have revealed a new megashear named here as Shontargali Thrust (ST) (Fig. 1). On the basis of its geographic location, stratigraphic setup and tectonic framework, the ST appears an analogue of the MCT.

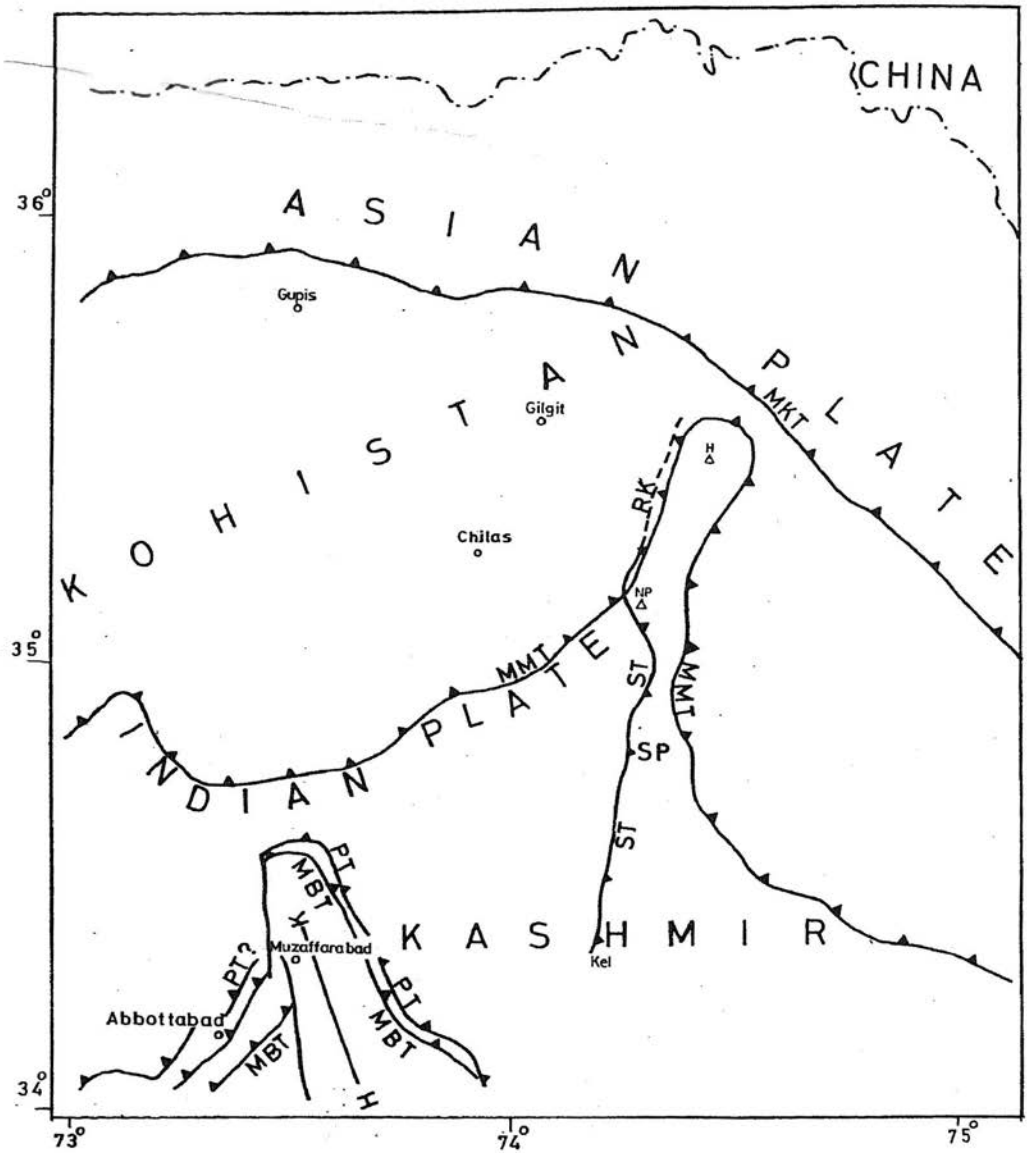

Fig. 1: Location of major structural features in the tectonic domain of Kashmir and NW Himalaya. MBT- Main Boundary Thrust, PT- Panjal Thrust, ST- Shontargali Thrust, RK- Raikot Fault, MMT- Main Mantle Thrust, MKT- Main Karakoram Thrust.

PANJAL THRUST

As the Panjal Thrust has been considered as an analogue of MCT in Kashmir and NW Himalaya, thus it becomes pertinent to reflect upon its tectono-stratigraphic frame for correlation purposes. According to Wadia (1931), this thrust separates the allochthonous folded belt from the nappe zone and demarcates two geotectonic zones, the Tethyan and the Lesser Himalayan. The Pir Panjal Range in Kashmir is the type section of the thrust where a Permo-Triassic sequence of agglomeratic slates and volcanics is thrust over by the Precambrian metasediments of the Salkhala Series. At Reshian and Khetar Tarcri sections in Kashmir, the Panjal Group also

incorporates dolomitic limestone, slates and minor sandy partings. The PT extends NNW and coalesces with the eastern limb of the Hazara-Kashmir syntaxis north of Neelam (Kishenganga) river and is traceable up to its apex.

The PT (Fig. 2) is imbricated in the footwall zone, resulting in slicing of various components of the Panjal Group. Bossart et al. (1988) have distinguished four major lithounits in the imbricated zone between the Neelam and Kaghan valleys. These are melange zone, tilloides, Panjal volcanics, and Triassic limestone. The Panjal imbricate zone in Kaghan valley also contains schists, crystalline dolomitic limestone, marble and greenschists. The PT can be distinguished from the MCT on the following grounds:

i. MCT is located between the Higher and the Lesser Himalaya whereas the PT appears on the southern fringe of the Kashmir Lesser Himalaya, closer to the Outer Himalaya.

ii. In the MCT, the Central Himalayan crystallines are thrust over the Jatog Fm (Salkhala Series), whereas in PT the Salkhalas are thrust over the Panjal Group of Permo-Triassic age, and

iii. The deformations associated with the PT are more on brittle side whereas ductile deformations are not as vivid as a deep level thrust such as the MCT usually indicates.

SHONTARGALI THRUST

The ST is located on the southeastern margin of the Nanga Parbat massif and roughly delineates a tectonic boundary between the Hazara-Kashmir Lesser Himalaya and the Nanga Parbat Higher Himalaya (Figs. 3, 4).

In the Indus valley, the ST (Fig. 5) follows the surfacial trace of the Raikot Fault (Lawrence and Ghauri, 1988) and for some distance runs through the eastern edge of the Kohistan island arc (Tahirkheli et al., 1976). After crossing the Indus river south of Sassi Punyari, the fault extends further north along Puparash-Darchan Gahs (streams) on the western flank of the Haramosh massif. In this section the ST and the MMT zones converge. The area beyond this point has not been studied because of ice-bound high relief, but it appears from topography and

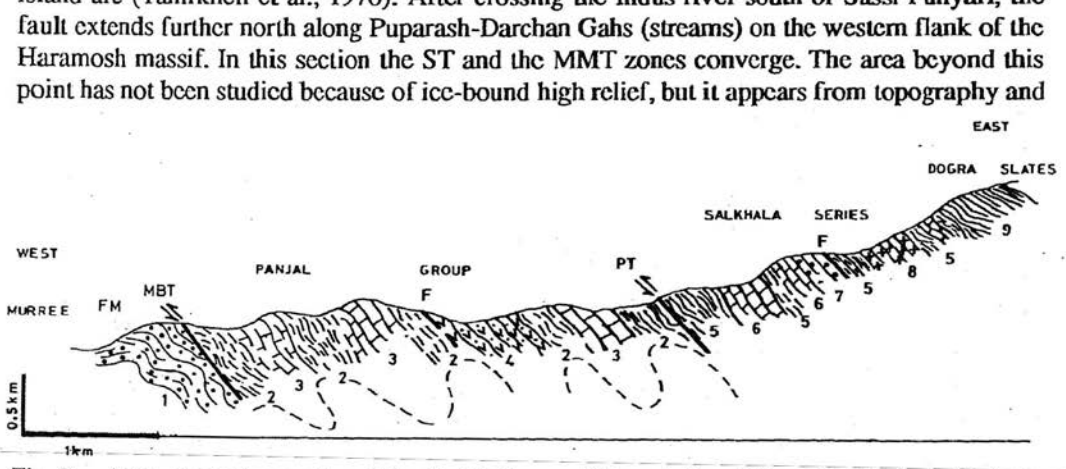

Fig. 2: Litho- Tectonic zonation of the Panjal Group at Nauseri along Nilam river in Azad Kashmir 1. Murree Fm., 2–4 Panjal Group: 2. Agglommeratic slates & Quartzitic sandstone, 3. Dolomitic limestone,4. Volcanics; 5–8. Salkhala Series: 5. Schists including graphitic schist: 6. Medium crystalline limestone and marble: 7. Quartzites: 8. Granitic gnessies: 9. Dogra Slates.

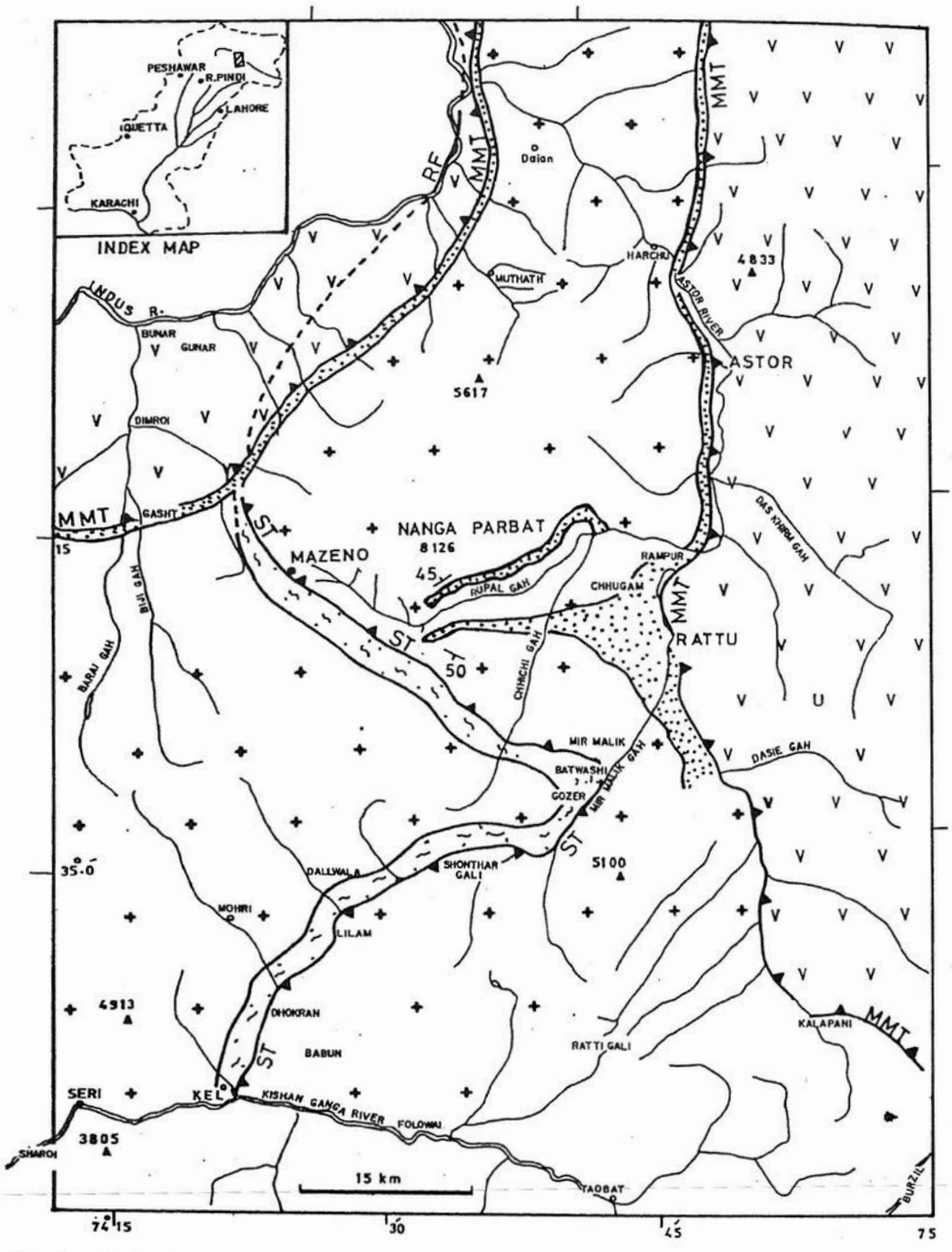

Fig. 3: Geological map showing the course of Shontargali Thrust in Kashmir and NW Himalaya. i. Nanga Parbat Guesses, ii. Burjiwale FM (Lower Salkhala), iii. Rattu Fm. (Upper Salkhala), iv Melanga zone- Kamila Amphibolite (Kohistan sequence). MBT- Main Boundary Thrust, PT- Panjal Thrust.

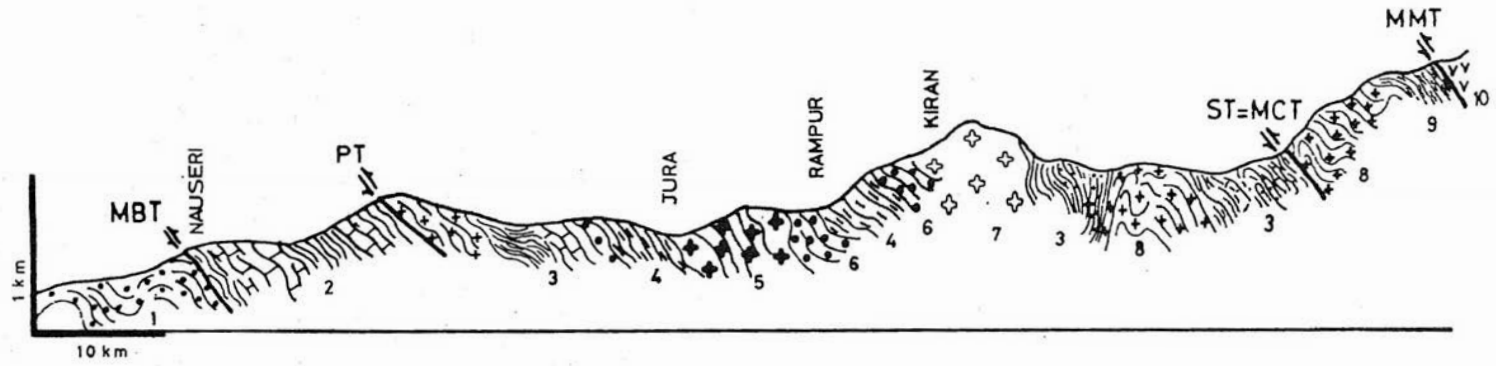

Fig. 4: Diagrammatic section along Nelam Valley in Azad Kashmir.

1. Murree Fm, 2. Panjal Group, 3. Salkhala Series, 4. Dogra Slates, 5. Jura granite and granite genisses, 6. Quartzitic sandstone, 7. Kiran granite, 8. Nanga Parbat gneisses, 9. Rattu Fm. (upper Salkhala), 10. Melange zone and Kamila Amphibolite (Kohistan sequence).

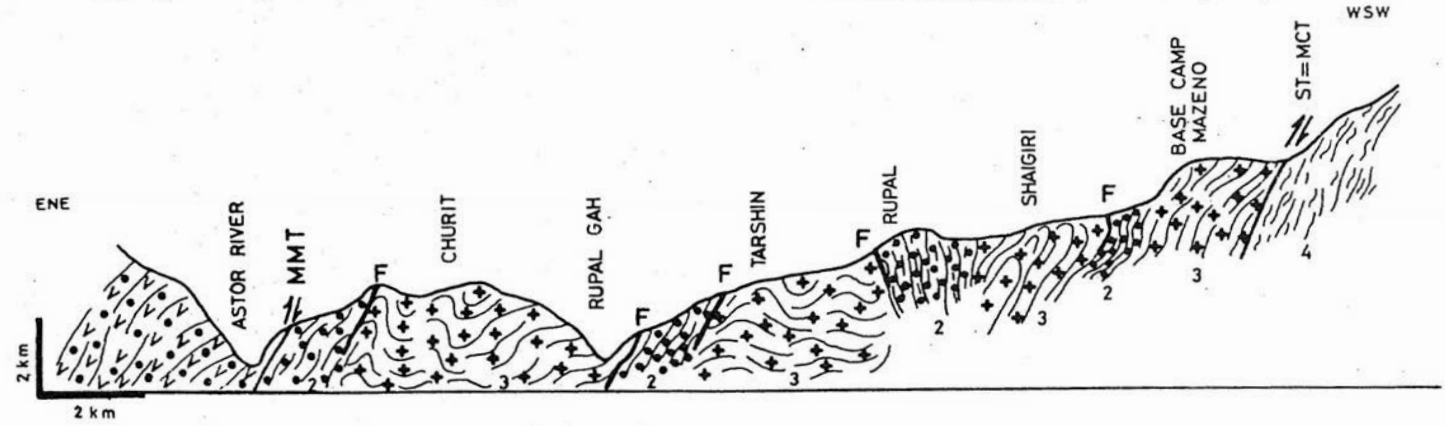

Fig. 5: Diagrammatic section across Astor river through Rupal and Mazeno.

1. Melange zone – Kamila Amphibolite, 2. Rattu Fm (upper Salkhala), 3. Nanga Parbat gneisses, 4. Burjiwala Fm. (Lower Salkhala)

MMT- Main Mantle Thrust, ST- Shontargali Thrust, MCT- Main Central Thrust.

tectonic behaviour of the fault, that the ST terminates in the vicinity of Puparash and Malubiting sub-chain of the Haramosh massif.

The ST covers between 3–4 Km wide zone (Fig. 1). It displays considerable changes in both strike (N, NNE to NW) and dip (30 to 66°). The high angle dip appears to be the result of post-thrust movements generated by the Nanga Parbat-Haramosh syntaxial tectonics.

Catalasites, mylonites, blastomylonites and migmatites are widespread in the thrust zone in which both the Nanga Parbat gneisses (hangingwall) and the Salkhalas (footwall) have been deformed, appearently at deep level.

A very interesting feature of the ST is the development of folds of enormous sizes in both the hanging and footwall zones (Fig. 6). In some sections these mega-folds are 2 to 3 km wide. In the footwall zone south of Shontargali Pass in Burjiwala nala (type section of the Lower Salkhalas) there are two huge, Juxtaposed, reclined synclines and an anticline separated

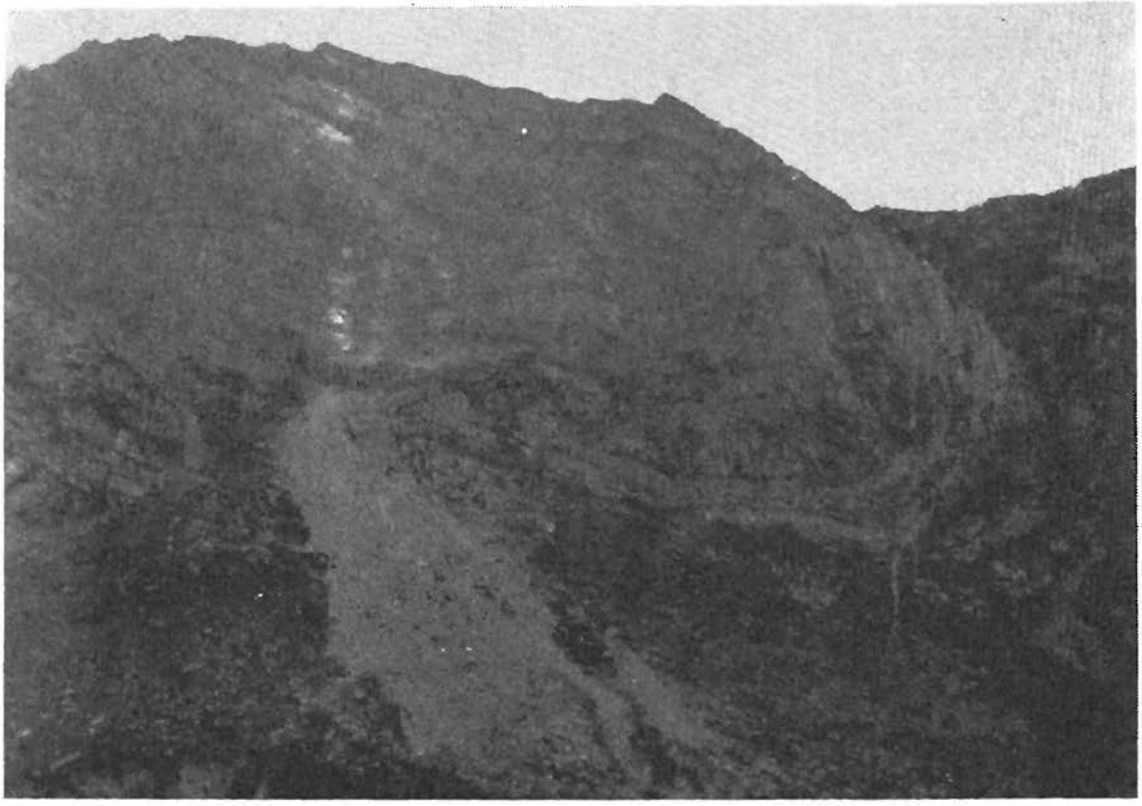

Fig. 6: Photograph showing a juxtaposed mega anticline and syncline developed along the footwall zone of the Shontargali Thrust in Burjiwala Stream in Azad Kashmir.

by a small fault. The rocks involved are peeled around the core of the folds and consist of garnet-mica schist, graphite gneiss and amphibolite, representing the Lower Salkhalas. The eastern limb of the anticline, involved in the thrust, displays well developed mylonite, blasto-mylonite and migmatite.

Imbrications in the footwall zone of Shontargali Thrust are very conspicuous in most of the sections where skittled and repeated sequences of the rocks involved are noticed. In many sections imbrications have given rise to duplex structures too.

Two major phases of deformation are manifested in the Shontargali Thrust. The earlier tectonic phase has yielded imprints of deep level deformation, such as micro-folds, mylonite, blastomylonite and migmatite which are usually concentrated in the vicinity of the footwall zone of the thrust. The development of magafolds and refolded folds as discussed earlier, are the product of the post-thrust involvement in the Nanga Parbat-Haramosh syntaxial tectonics, which according to Zeitler et al. (1989) remained active as late as Pliocene-Early Pleistocene time.

GEOLOGICAL SETUP

In the Shontargali Thrust the rocks involved belong to the Lesser and the Higher Himalayan stratigraphic domains. The Salkhala Series, which forms the base of the Lesser Himalayan Precambrian sequence in Kashmir and NW Himalaya, is involved in the Shontargali Thrust and because of its huge thickness and variegated lithology has been termed by Stocklin (1980) as "the unpaged historic manuscript".

The Salkhala Series has got a widespread distribution and huge thickness. Very little attention, however, has been paid to establish its proper stratigraphic order based on its litho-logy In comparison to its counterpart (Jatog Fm) in the Western Himalaya. In the area under study, a two fold division of the Salkhalas, can be made into the Rattu Formation (Upper Salkhalas) and the Burjiwala Formation (Lower Salkhalas).

The type section of the Rattu Fm is located in the vicinity of Rattu town, about 25 km south of Astor. In this formation schistose component is dominant, which consists of garnet-mica schist, carbonaceous schist, talc schist, calc schist, chlorite schist, semi- to medium-crystalline dolomitic limestone, and quartzitic sandstone, with minor and erratic association of gneisses. These are intruded by granite, dolerite and amphibolite sills and dykes.

The type section of Burjiwala Fm is located on the south of Shontargali Pass, in a substream of Barai in Kashmir. Its rock assemblage includes garnet-mica schist, graphitic schist, thick bedded to massive quartzite, medium crystalline dolomitic limestone, thick to thin bedded coarse to very coarse marble which contains erratic ruby mineralization along with biotite- and quartzofeldspathic gneisses. Among the intrusions, pre- and post-tectonic granites, diorite, dolerite and amphibolite sills and dyke are common.

The Rattu Fm shows greenschist facies metamorphism, but in structurally disturbed sections the metamorphism could rise to higher grade. In Kashmir and south of Astor, the Rattu Fm is involved in the Main Mantle Thrust (ISZ) along which it subducts the Kohistan Island arc. The Burjiwala Fm shows a relatively higher grade of metamorphism, to kyanite and sillimanite zones. It is involved in the Shontargali Thrust and is developed in the footwall zone.

The Salkhala Series of Kashmir and NW Himalaya is correlated with the Jatog Fm and Chail Fm of western Himalaya and Garhwal Gr., Dubatoli Gr., Thimpu Fm, and Sumar Fm of the Central and the Eastern Himalaya (Pati and Rao, 1983). All these groups and formations are involved in the MCT and are thrust-over by the Central Himalayan crystallines.

The Higher Himalayan sequence in the Central and the Western Himalaya is variously designated as Central Himalayan crystallines (Heim and Gansser, 1939), Tibetan Slab (Bordet, 1979) and Vaikritta Group (Valdiya, 1980). In the NW Himalaya these are correlated with the gneisses of Nanga Parbat-Haramosh massif (NP-H). The two important and easily accessible sections which cut across the massif are Astor and Indus valleys, exposing fresh outcrops, and providing an indepth view of the rock assemblage in the western, central and the eastern parts of the massif.

The massif comprises mainly of porphyritic and blastoporphyritic quartzo-feldspathic and biotite gneisses, the latter being dominant. Augen structure in the gneisses is not uncommon. Deep level deformation in the gneisses is conspicuous on the fringe and the central part of the massif, which are dotted with mylonitic and migmatitic zones.

Besides gneisses, the NP-H massif contains schist, minor quartzite, medium crystalline dolomitic limestone and marble which constitute 10–15% of the whole rock assemblage. These rocks are usually found on the fringe of the massif, but some form thin bands in the central part too. Part of these metasedimentary assemblages represent the Lesser Himalayan facies which were tectonically incorporated during the two major events, the Main Mantle Thrust (ISZ) and the Shontargali Thrust. Among the intrusives the massif also contains post-tectonic granites, pegmatite, aplite, diorite, dolerite and amphibolite sills and dykes.

Recent studies of zircon and amphibole derived from the NP-H gneisses and granites, using U/Pb, Ar40/Ar39 and K-Ar methods, yielded three distinct age groups of Ca 1800–2700 Ma, Ca 500–600 Ma and Ca 10–58 Ma (Zeitler et al., 1989). The oldest age pertains to the Nanga Parbat gneisses and on the basis of this age, these gneisses may be correlated with the Central Himalayan Crystalline, Vaikritta group and Tibetan Slab of rest of the Himalaya.

SHONTARGALI THRUST VERSUS MAIN CENTRAL THRUST

In the following, the geographic, stratigraphic and tectonic settings of the Shontargali Thrust have been compared with the Main Central Thrust to pinpoint similar features shared by these thrusts which could justify their correlation:

TABLE 1. COMPARISON BETWEEN THE SHONTAR GALI & MAIN CENTRAL THRUSTS

		MCT	ST
i.	Geographic Location:	This thrust roughly demarcates a boundary between the Lesser and the Higher Himalaya.	Located at the base of Nanga Parbat massif (Higher Himalaya) and over Kashmir-Hazara Lesser Himalaya.
ii.	Stratigraphic Setup:	The rocks involved in the thrust are Jatog Fm and its equivalents of the Lesser Himalaya and the Central crystallines and their equivalents of the Higher Himalaya.	The rocks involved in this thrust are the Salkhala Series of the Kashmir-Hazara Lesser Himalaya and the Nanga Parbat gneisses of the Higher Himalaya.
iii.	Tectonic Frame:	Jatog Fm and its equivalents are thrustover by the older Central Himalayan gneisses of the Higher Himalaya.	The Salkhala Series of the Lesser Himalayan is thrustover by the Nanga Parbat gneisses of the Higher Himalaya.
iv.	Deformation Pattern:	Deformation relating to deep level metamorphism such as association of mylonite, blastomylonite and migmatite are commonly noticed in the thrust zone.	Mylonite, blastomylonite and migmatite have frequent association with the thrust zone.

CONCLUSIONS

On the basis of field evidences gathered on the Shontargali Thrust, the following conclusions are drawn:

1. The ST is a new addition to the orogenic domain of Kashmir and NW Himalaya and is considered an analogue of the MCT.

2. The ST is an intra-crustal thrust like the MCT, developed as a result of collision between the Indian and the Eurasian (+ Kohistan arc) plates. Folding, shearing, mylonitization and migmatization are associated with thrusting and suggest deformation at depth at crustal level. The ST located between mesograde underthrusted Salkhalas and overthrusted meso- to katagrade Nanga Parbat gneisses, occupies a tectonic level equivalent to the Vaikritta thrust (MCT) as demarcated by Valdiya (1980) in the Central Himalaya.

3. The creation of the ST can be tied up with the closure of the Neotethys and Eocene collision between India and Asia along the MMT. It started developing during Oligocene when the subduction of the Indian plate had started underneath the Eurasian plate. This tectonic model for the origin and development of the Shontargali thrust favourably compares with that of the MCT.

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REFERENCES

Bordet, P., 1979. Geology of the Tibetan Slab (Central Himalaya). In: Structural Geology of the Himalaya, (P.S. Saklani, ed.), Him. Books, New Delhi, 229–246.

Bossart, P., Dorothee, D., Greco, A., Ottigar, R. & Ramsay, J.G., 1988. The tectonic structure of the Hazara-Kashmir syntaxis, southern Himalaya, Pakistan. Tectonic, 273–297.

Gansser, A., 1976. Ophiolitic belts of the Himalaya and Tibetan Regional, Int. Geol. Correlation Programme, UNESCO.

_____, 1980. The division between Himalaya and Karakoram. Proc. Intern. Commit. Geodynamics, Grp. 6mtg. Spl. Issue Geol. Bull. Univ. Peshawar 13, 9–22.

Heim, A. & Gansser, A., 1939. Central Himalaya: Geological observations of the Swiss Expedition, Denkscher. Shweiz. Naturfoch. Ges. 73, –245.

Lawrence, R.D. & Ghauri, A.A.K., 1988. Evidence of active faulting in Chilas district, Pakistan. Geol. Bull. Univ. Peshawar 16, 185–186.

Le Fort, P., 1975. Himalaya: The collided range. Present knowledge of the continental arc. Am. J. Sci. 275A, 1–44.

Pati, U.C. & Rao, P.N., 1983. Geotectonics of the Main Central Thrust of U.P. Himalaya. In: Himalayan Shears (P.S. Saklani, ed.). Him. Books, New Delhi, 68–83.

Sinha, A.K., 1987. Tectonic zonation of the Central Himalaya and the crustal evolution of collision and compressional belts. Tectonophysics 134, 59–79.

Stocklin, J., 1980. Geology of Nepal and its regional frauce your Geol. Soc. London 137, 1–34.

Tahirkheli, R.A.K., Mattauer, M., Proust, F. & Tapponnier, P., 1976. Some new data on the India-Eurasia convergence in the Pakistani Himalaya. Coll. Intern. CNRS, Eclo. Geol. Himalaya, 268, 220.

_____, 1979. The Indian-Eurasian suture zone in northern Pakistan: synthesis and interpretation of data at plate scale. In Geodynomics of Pakistan, (A. Farah and K.A. Dejong, eds.). Geol. Surv. Pakistan, Quetta, 125–130.

Tahakur, V.C., 1981. An overview of thrusts and nappes of Western Himalaya. In: Thrust and Nappe Tectonics, the Geol. Soc. of London.

_____, 1983. Palaeotectonic evolution of Indus-Tsangpo suture zone in Ladakh and southern Tibet. In: Geol. of Indus Suture Zone of Ladakh, (V.C. Thakur & K.K. Sharma eds.). Wadia Inst. of Himalayan Geology, Dehra Dun, India, 195–204.

Valdiya, K.S., 1980. The two Intracrustal boundary thrusts of the Himalaya. Tectonophysics 66, 323–348.

Wadia, D.N., 1931. The syntaxis of North-West Himalaya: Its rocks, tectonics and orogeny. Rec. Geol. Surv. India 65, 189–220.

Zeitler, P.K., Sutter, J.F., Williams, I.S., Zartman, R. & Tahirkheli, R.A.K., 1989. Chronology and temperature history of the Nanga Parbat-Haramosh Massif, Pakistan. Geol. Soc of America, Specl. Paper 232, 1–22.