

Word document

Docket 2 Himalayan geology Jan 2014

DOCKET 2 - *An integrated Study of Himalaya - Structure*

An Integrated Study of Himalayan Structure

A study of the macrostructure of the Indian subcontinent involves the use of very extensive and intensive data from various sources. In particular these are the topo sheets of the Survey of India, the Geological Map of India, Gansser's map of the Himalaya and finally the gravity anomaly map- both ground and satellite maps. While geologists are normally familiar with the first three, the significance of the gravity map is yet to be appreciated.

It is almost impossible to study the subsurface below the Himalayan thrusts without relating them to the structure of the foredeep, as the latter project under the thrusts. Therefore in the descriptions below some attention has been paid to the structural elements in the foredeep. Maps depicting the structure of the foredeep under the Himalayan thrusts are shown below;

Slide 1

The composite gravity map of the subcontinent including the Bay of Bengal, the Arabian Sea, Pakistan, Nepal, Tibet and Burma can be seen in the first slide. This is used as the base for the tectonic map of India. The Himalayan region is bounded on its two sides by zones of high gravity gradients. There is a rapid increase in Moho depths across these zones. It is about 35 km. in the shield area, increases to around 45 km in the Lesser Himalaya and to about 75 km in the High Himalaya and Tibet

Slide 2:

This is a deep seismic section on the Kashmir to Pamir profile. The first drop in Moho occurs across the Panjal Thrust. The second drop in Moho occurs just north of the Wular Lake at the junction of the High Himalaya.

Slide 3:

This second deep seismic profile goes north from the Bihar plains across Nepal and S.Tibet. The first drop occurs

near the Main Boundary Fault, the second in the High Himalaya region.

The sudden changes in crustal thicknesses has an important consequence. The thicker the crust, the less its average density, bringing into play the effect of isostasy. It explains the uplift of Nepal in relation to the plains and the subsequent uplift of the Himalaya and Tibet.

Slide 4:

This is a direct interpretation of the gravity map . The division of N.India into NS and eastern segments is clearly seen. This leads to a detailed Tectonic Map of the subcontinent. North and West India is built around two cratons, namely the Marwar and Bundeikhand cratons. The Marwar craton is enveloped by the Aravalli system. The Sarghoda and Lahore ridges form parts of the craton. The Aravalli Ambala ridge, and the Delhi- Hardwar ridge form the Aravalli system. Incidentally the Delhi – Hardwar ridge form the western boundary of the Vindhyan deposits of the Ganga Valley . The Moradabad fault is the southern / southeast boundary of the two Aravalli ridges. It is a continuation of the Banas dislocation of the Aravalli Range. Towards the north the Hardwar Ridge dips under the Dun Valley between the Ganga and Yamuna shears and then again under the MBF north of Dehra Dun. Across the MBF the Delhi-Hardwar ridge can be traced northwards with its axis enveloping the Deoban peak. Still further north it encloses the Larji- Rampur window . This northern block ends with the Dhauladhar Range. Thereon it swings NW to enclose the Chamba and Kashmir vallies, ending in the Indus suture.

The northeastern edge of the Ambala ridge is occupied by a major fault with several kilometers throw. This forms the western limit of the Siwalik sediments of Himachal Pradesh. The Am.bala Ridge is a northward extension of the Aravalli Range. It is subsurface from Delhi northwards and dips sharply near the Indus River to form the base for the Siwalik deposits of Himachal Pradesh. The eastern edge of the NW Himalaya

separates the Lesser Himalaya from the High Himalaya and Spiti. There is a major crustal change across this line.

The Bundelkhand craton is followed up in the north by the Lakhimpur ridge that extends eastward across the MBF into eastern Nepal and western Bhutan. Another east-west ridge can also be seen from the Gandak river upto Kishangarh. The Sarada Basin lies between the Hardwar and Lakhimpur ridges .

Slide 5:

This is the satellite gravity map of Garhwal and Kumaon. Taking off eastward from the Delhi-Hardwar ridge are the Garhwal Nappe and the uplift defined by the Inner Sedimentary Basin. The large gravity high (Ganga High) within the region of the latter is a basement high that controls the southward push of the High Himalaya.

Immediately to north of the Ganga High lies the line of high peaks stretching from Bander Punch to Badrinath. The line turns south enveloping the Ganga High and contains the peaks of Nanda Devi and Trisul. It then runs eastwards upto Saipal where it is intercepted by the Karnali High. The latter then continues northeastwards to form the western limit of the Karnali High, which in turn terminates the Inner sedimentary basin and east-west line up of the peaks. Like the Ganga High, the Karnali High is also a large basement feature.

The line of high peaks (which was interrupted by the western edge of the Karnali high) resumes on its eastern edge and swings round through Everest and Kanchenjunga upto W.Bhutan. The crystalline thrust extends south of the line of peaks until it comes up against the Jajarkot Nappe on the one hand and the eastward extension of the Lakhimpur ridge on the other.

Slide 6: is the satellite gravity map of E.Nepal. Two versions are shown. The high frequency version reveals the anticlinal structure commencing from the Lakhimpur ridge in the plains, across the MBF and further east in Nepal. The southern fault of the Lakhimpur ridge cuts through the MBF to dissect the composite anticline (Judi Fault) and change its orientation. The low frequency version resolves the N-S

domal structures of E.Nepal and Sikkim. These are the Sikkim dome, The Tamur dome, the Arun dome and two others. These structures do not extend beyond the Judi Fault. The anticlinal axis extends into W.Bhutan, where it is recognized as the Paro metamorphic.

Slide 7: is the Geological Map of E.Nepal. The close correspondence of the low frequency gravity map with the geological map in the area of domes is remarkable.

Slide 8: is the satellite gravity map of Arunachal Himalaya. It is quite clear that the Arunachal Himalaya directly overlaps the NE extension of the peninsula proper. The lineup of high peaks is strongly interrupted in W.Bhutan by a major NS fault, beyond which the crystalline thrust moves south to overlap the peninsula.

Slide 9: shows the general basement configuration of the Himalaya. The line of major crustal change is indicated by the thick blue line. There are three controlling ridges. These are the Delhi-Hardwar ridge, the Lakhimpur ridge and the Kumaon ridge (Inner sedimentary basin). These are succeeded by four nappes, namely the Kashmir-Chamba nappe, the Garhwal nappe, the Jajarkot nappe and the Kathmandu nappe.

Slide 10: reproduces three geological sections illustrated in Gansser's book on the Himalayas. The correspondence with the satellite gravity data is striking.

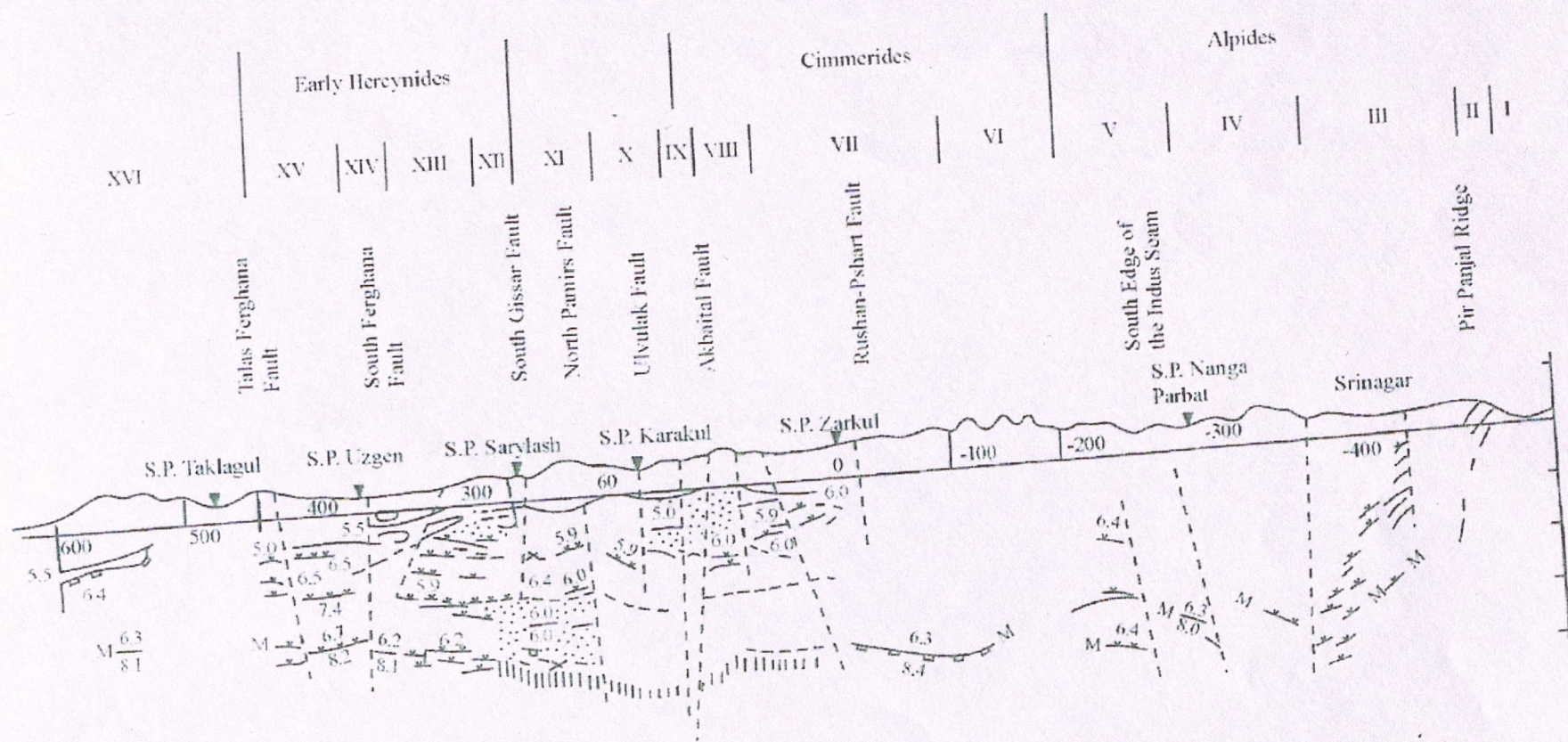


Fig.43 DSS profile from Kashmir to Pamir

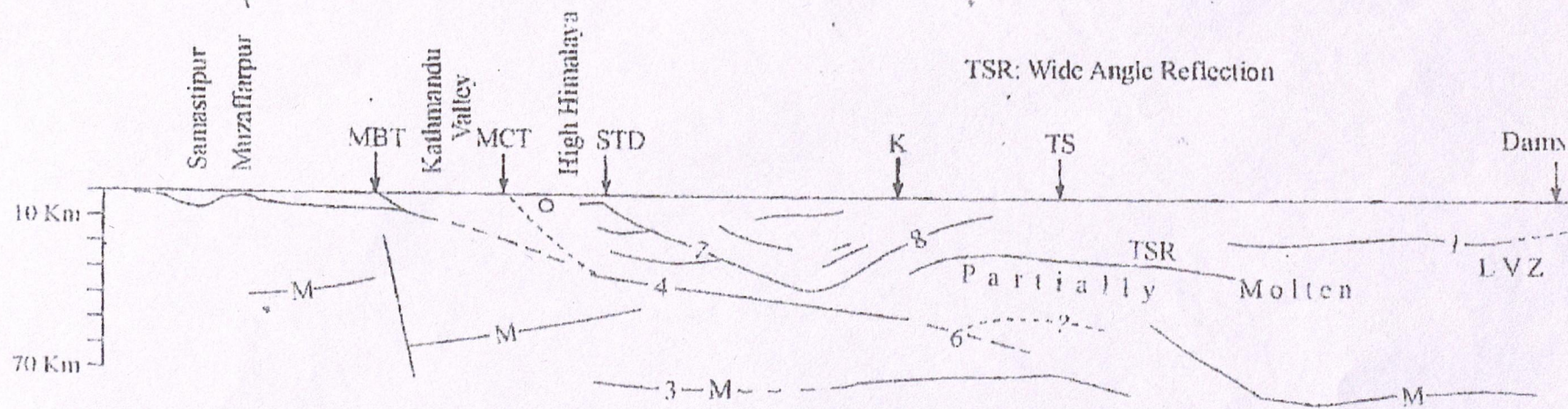
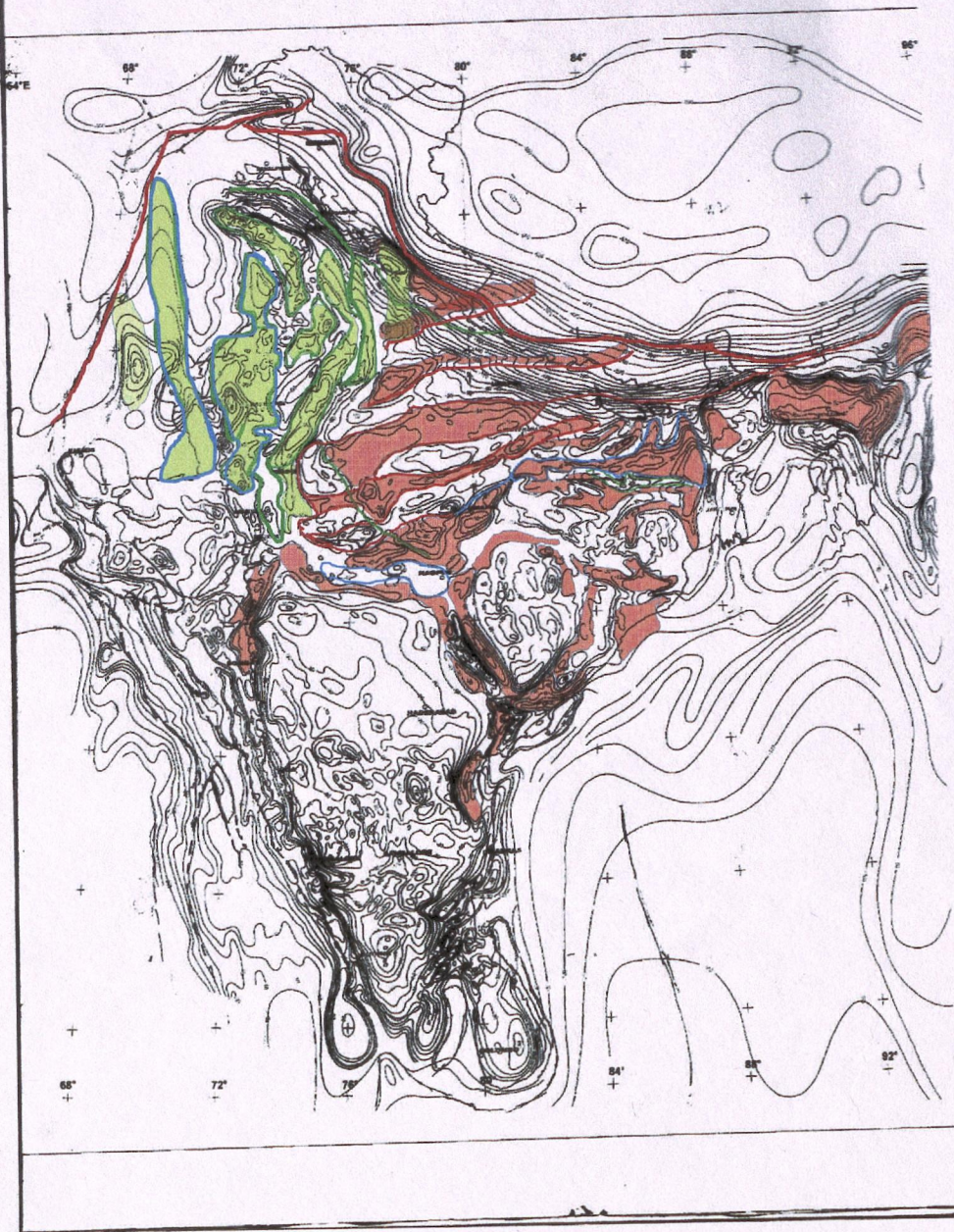
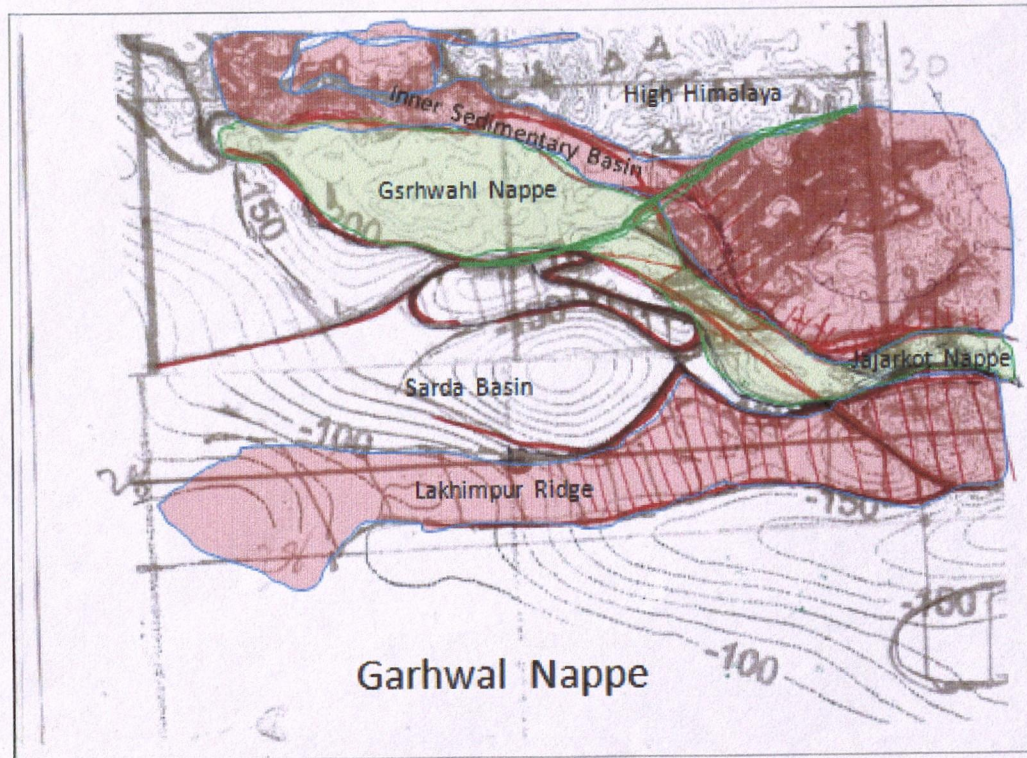


Fig.40 Composite INDEPTH I-II CMP Profile

Slide 4

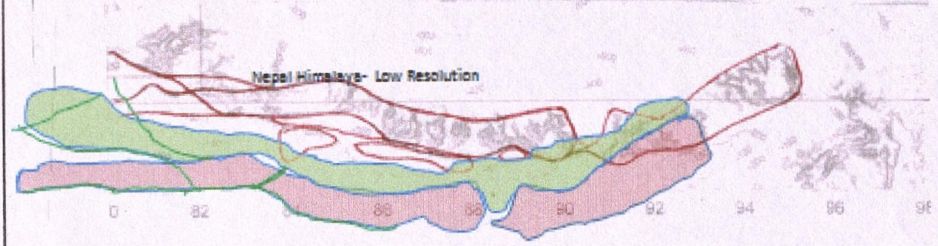
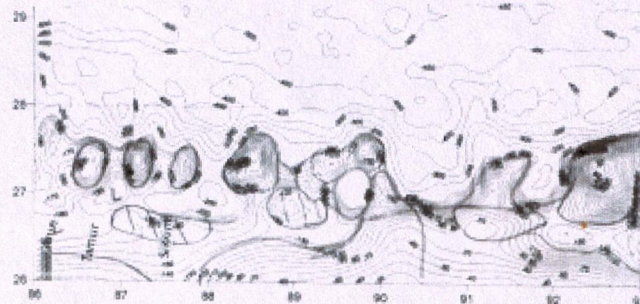


Slide 4



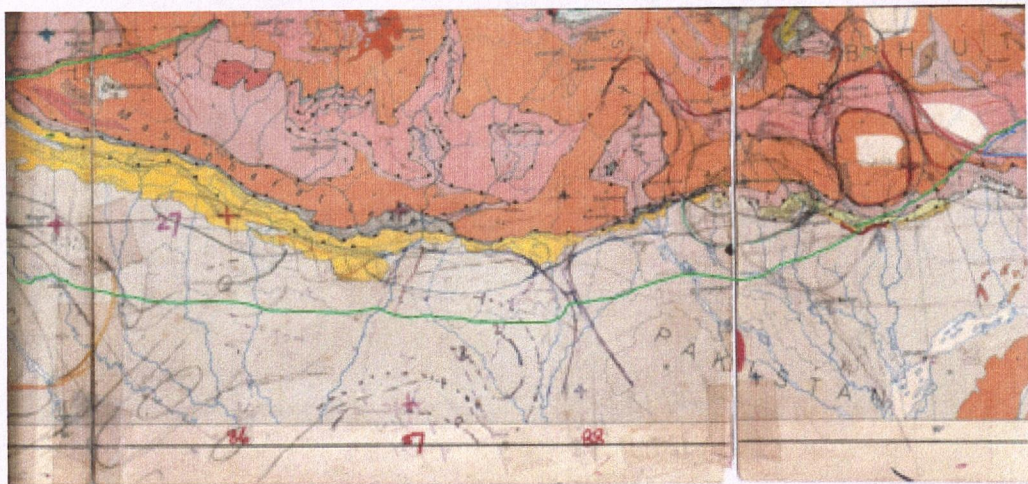
slide 5.

Slide 6

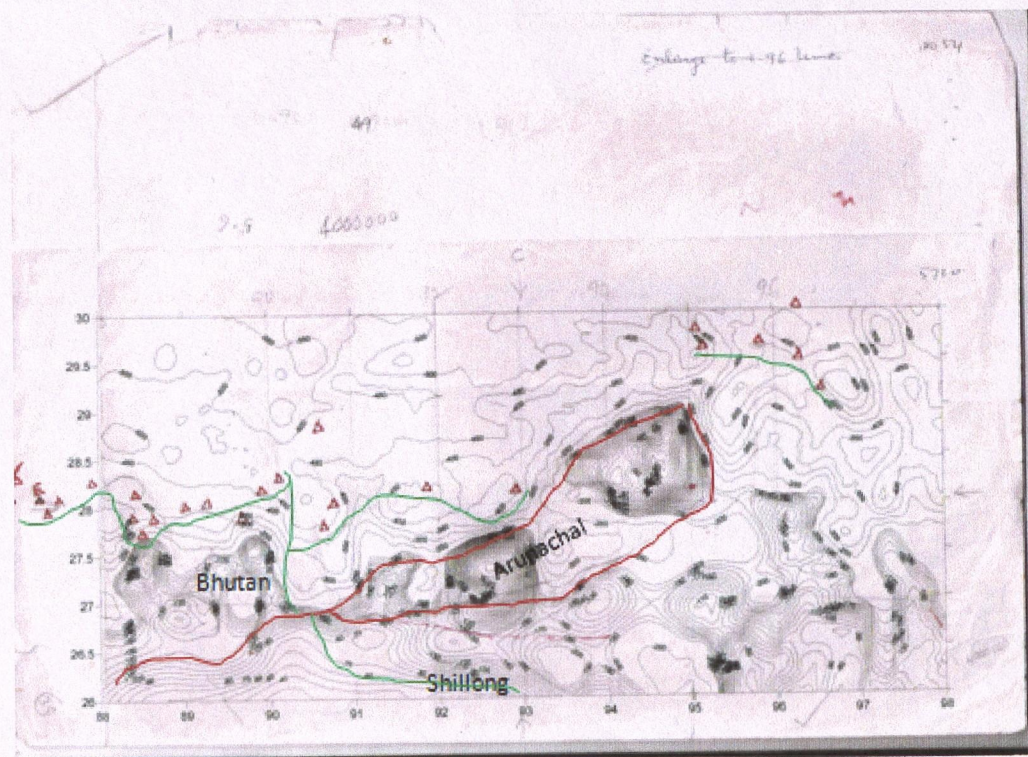


Nepal Himalaya-High Resolution

Slide 7

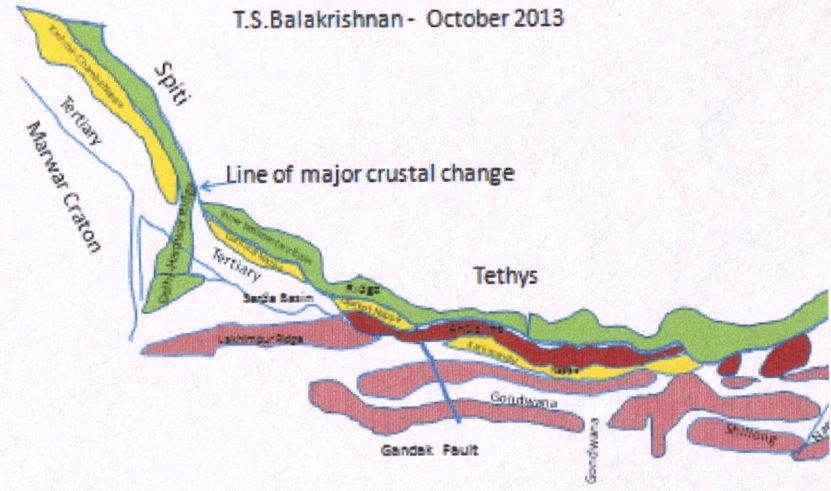


Slide 8



Basement structure of Himalaya
T.S. Balakrishnan - October 2013

Slide 9



Slide 10.

