Arguments for the Autochtony of the Tibetan Zone

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Arguments for the Autochthony of the Tibetan Zone

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ABSTRACT

In a series of recent papers the Tibetan Zone is accepted as an allochthonous mass resting on the Central Crystalline and being composed of subsidiary nappes. The author found many facts inconsistent with this hypothesis:

1. Near the Indus Suture Zone of Ladakh the shelf carbonates are reported to rest tectonically on the Langtang-Lamayuru Belt implying that they are derived from further N. Actually they interfinger with the Lamayuru Formation indicating a passage into the northern basin facies. This transition is documented in the Nimaling area.
2. Along the southern boundary of the Tibetan Zone passages between the Central Crystalline and the sedimentary rocks prove the primary connection in most regions of the Himalaya. A large portion of the crystalline consists of metamorphosed Tethys sediments. Local disturbances of the crystalline/sediment contacts are no evidence for nappe tectonics.
3. This connection of the crystallines and sedimentary rocks is also observed in the Synclinoria of Kashmir and Chamba, which are continuous with the Tibetan Zone via Lahoul.
4. The unconformable basal contact of the Panjal Trap of southern Zanskar was taken as nappe boundary. Detailed studies showed a thin band of clastic rocks transgressing on various Palaeozoic formations. It is followed by the Trap with a magmatic contact. No trace of a thrust was found.
5. Numerous dikes of Panjal Trap penetrate the underlying formations showing that these represent the original substratum of the flows and not a foreign tectonic unit.
6. In the Mesozoic sequence of Zanskar some folds show sheared limbs, which were interpreted as nappe boundaries. Followed along the strike they lose their importance and turn out to be just wedges or reversed faults.
7. The Tibetan Zone of Zanskar was assumed to be a pile of nappes. But its succession, though folded and locally sheared is still in normal stratigraphic order. Like in other parts of the Tethys Zone the direction of folding varies from NE to SW. In absence of windows and outliers there is no reason to assume the existence of thrust sheets within the Tibetan Zone.

Thus the Precambrian to Early Tertiary sequence of the Tibetan Zone represents a *stratigraphic succession.* Its lower portions were altered up to various levels and became part of the Central Crystalline. Therefore the sediments are structurally inseparable from the underlying Crystalline.

ZUSAMMENFASSUNG

In einer Reihe neuerer Arbeiten wird die Tibet-Zone als allochthone Masse auf dem Zentral-Kristallin aufgefasst. Weiter soll sie aus mehreren Teildecken bestehen. Der Autor bringt gegen diese Vorstellung folgende Einwendungen:

1. Die Zanskar-Schelf-Karbonate sollen im N die Langtang-Lamayuru-Zone tektonisch überlagern, was bedeutet, dass sie von weiter nördlich aus der Indus-Sutur-Zone stammen. Tatsächlich sind die Schelf-Karbonate mit den im N angrenzenden Beckensedimenten faziell verzahnt. Dieser Übergang ist im Markha-Nimaling-Gebiet zu verfolgen.

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2. Am S-Rand der Tibet-Zone finden wir Metamorphose-Übergänge zum Zentral-Kristallin, welche eine primäre Verbindung belegen. Metamorphe Tethys-Sedimente bauen einen Teil des Kristallins auf. Dass der primäre Verband örtlich gestört ist, kann nicht als Beleg für Deckenbau herangezogen werden.
3. Dieser primäre Zusammenhang des Kristallins mit den überlagernden Sedimenten ist auch in den Synklinorien von Kashmir und Chamba zu beobachten, welche über Lahoul mit der Tibet-Zone verbunden sind.
4. Die diskordante Basisgrenze des Panjal-Trap im südlichen Zanskar wurde als Deckengrenze aufgefasst. Eine genauere Untersuchung zeigte einen Horizont gering mächtiger klastischer Gesteine als Transgressionsbildung über verschiedenen paläozoischen Formationen. Darüber folgt der Trap mit magmatischem Kontakt. Es zeigte sich keine Spur einer Überschiebung.
5. Zahlreiche Gänge von Panjal-Trap durchschlagen die unterlagernden Formationen. Dies beweist, dass diese nicht eine fremde tektonische Einheit sondern die ursprüngliche Basis der Laven darstellen.
6. In der mesozoischen Folge von Zanskar sind die Flanken einiger Falten ausgeschert, was als Deckengrenze aufgefasst wurde. Folgt man diesen Scherzonen, verlieren sie sich meist und wir finden die primäre stratigraphische Folge. Es handelt sich damit bloss um Schuppungen.
7. Die Tibet-Zone von Zanskar wurde als Stapel von Teildecken angesehen. Tatsächlich finden wir die normale stratigraphische Abfolge, wenn auch gefaltet und örtlich gestört. Wie in anderen Gebieten der Tibet-Zone ist die Faltenvergenz teils SW-, teils NE- gerichtet.

Wir finden somit in der Tibetischen Zone eine *stratigraphische Abfolge.* Deren basale Teile wurden bis zu unterschiedlichen Niveaus metamorph und somit Teil des Zentral-Kristallins. Örtliche Störungen sind kein Beweis für Deckenbau, hierfür wären *Umkehr der Schichtfolge, Deckschollen und Fenster nötig.* Solche existieren nicht und wurden auch von den Befürwortern des Deckenbaues nirgends glaubhaft gemacht.

1. Introduction

Like the Alps the Himalaya is an outstanding example for nappe tectonics. In the Lesser Himalaya there are numerous outliers of thrust masses consisting of high-grade metamorphic sequences or old formations. Younger, partly fossiliferous series are found underlying the thrusts and are exposed in several tectonic windows.

Recently also the northern sedimentary zone of the Himalaya – the Tibetan or Tethyan Zone – is accepted as an allochthonous mass resting tectonically on the Central Crystalline (Baud et al. 1982a, b). The Tibetan Zone itself has been interpreted as representing a pile of nappes (Baud et al. 1984; Gaetani et al. 1985 a.o.).

This latter concept is inconsistent with the gradations between the Tibetan Zone and the Central Crystalline described from many parts of the Himalayas (Heim & Gansser 1939; Gansser 1964, 1983; Fuchs 1967, 1975; Bordet et al. 1971, 1975 a.o.). The nappe concept implies that the Zanskar shelf series are derived from between the Langtang – and Markha (Lamayuru) basin series (Baud et al. 1982b, Fig. 4). In a later paper (Garzanti, Baud & Mascle 1987) the Zanskar series are accepted as shelf deposits on the northern margin of the Indian Continent. Surprising is the fact that the stratigraphic sequence of the Tibetan Zone has not been disturbed by the supposed thrusts. No outliers or windows are referred to as evidence for the nappe structures of the Tibetan Zone, only shear zones and disturbed formation boundaries were described.

For the above reasons I was in doubt about the nappe hypothesis and studied a series of critical areas in the Ladakh-Zanskar region (Fuchs 1986, 1987). My objections against the nappe concept and arguments at the discussions during the Lausanne Colloquium (October 1988) are briefly summarized in this paper.

2: The Northern Margin of the Tibetan Zone

Investigations in the Markha-Nimaling area of Ladakh showed the Zanskar shelf sediments interfingering with the Lamayuru basin series. Within the latter zone the lime content further decreases towards the north and basic volcanics come close to the Omlung melange zone. Thus the facies belts shelf – continental slope – basin – subduction zone are found in their original position in relation to each other: their connection is more or less preserved (FUCHS 1986). BAUD (1988) opposes this facies passage by presenting the argument (1.) that TALON found at least 2 major thrusts. This is a misunderstanding, because TALON (1988) subdivided the Omlung melange-suture zone into two structural units, whereas, I described facies gradation from the shelf *to* the suture zone. The identification of this facies passage is not modified by the recognition of the thrust *within* the Omlung melange. In fact I expect that there are even more than two structural planes. The passage from the shelf to the basin deposits can be observed in the sedimentary rocks in the flanks of the Nimaling-Tso Morari Crystalline Dome. STUTZ & STECK (1986) emphasize the tectonization of the sedimentary series of this area and accept a "Langtang Nappe" (BAUD 1988, argument 2). I agree that there is much deformation in the ductile Langtang rocks which led to large recumbent folds. Further the sedimentary succession was disturbed by shear planes producing either repetition or pinching out of formations (STUTZ & STECK 1986; FUCHS 1986, p. 422, Pl. 2, 3). But these complications affect the whole Precambrian to Eocene stratigraphic succession of the Tibetan Zone and do not imply a pile of nappes. If the "Langtang Nappe" actually existed, the Zanskar shelf sediments were derived from between the Langtang roots and the Markha (Lamayuru) Zone. In this case they would have been deposited on a swell between two troughs (Langtang and Markha). This implies that the northern margin of the Indian Continent would be deprived of its shelf sediments. On the contrary there is the lateral passage from the basin facies in the north to the shelf series deposited on the margin of the Indian Continent: the Lamayuru-Markha series comprise almost the whole of the Mesozoic in basin facies north of the Nimaling Dome. South of it the Langtang basin facies rocks represent the major portion of the Triassic and are stratigraphically followed by the Kioto Limestone. Thus the basin facies is progressively replaced by shelf facies rocks towards the south. The Mesozoic shelf carbonates of Zanskar were never deposited north of the Nimaling-Tso-Morari anticlinorium and therefore have to be regarded as autochthonous.

3. The Tectonics of the Tibetan Zone

In the Zanskar Synclinorium BAUD et al. (1982a, b, 1983, 1984) recognize a series of nappes within the Tibetan Zone. Linear shear zones like the Kangi-Naerung Fault or disturbed formation boundaries are accepted as nappe boundaries. Some of these shear zones end after a few km, others like the Kangi-Naerung Fault or the Northern Zanskar Unit Thrust may be traced for 70–80 km to finally end in folded but coherent stratigraphic sequences. Thus the "Zumlung Nappe" NE of Zangla represents the NE-limb of the Zangla Syncline, claimed to belong to a lower unit – the "Zangla Nappe". FUCHS (1982, 1987) showed that the Kangi-Nearung shear zone ends west of Zangla respectively west of Kangi, where the stratigraphic succession is still preserved, though strongly folded. After GILBERT (1986) had confirmed this observation the French geo-

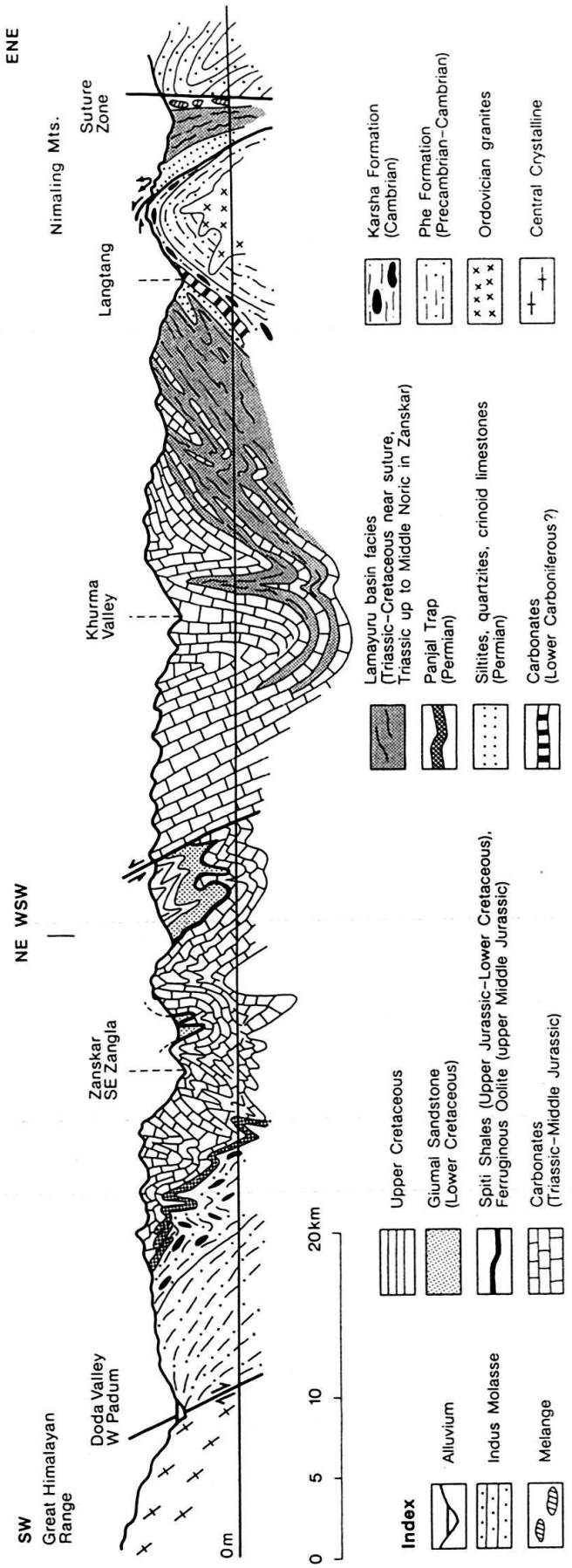

Fig. 1. Section across the Zanskar Synclinorium from the Great Himalayan Range to the Indus Suture Zone.

logists dropped the idea of a "Zanskar-Shillakong Nappe" (COLCHEN pers. communication, 1986).

It is very common in the Tibetan Zone that reversed faults, wedges, etc. develop from folds. A combination of folding and disharmonic tectonics is frequently found where adjoining formations show different competency (HEIM & GANSSER 1939; FUCHS 1967, 1977a). Recent studies in the Kong-Chulung area of Zanskar revealed that wedge structures locally develop from folds. We therefore find different "thrusts" on both sides of the Chulung Valley, which do not cross the valley and which show movement in opposite directions. Such changing vergence is typical of the tectonics of the Tibetan Zone, except where higher thrust masses have overridden it (e.g. Spongtang, Kumaun).

Sheared formation boundaries or intensive tectonic disturbance are not sufficient to prove the existence of nappes. In the Lingshet area wedges of the Shillakong (Fotu La) Formation pierce the overlying Lamayuru (Goma) Shales. The strong deformation has been taken as evidence for the existence of a "Lingshet Nappe" by GAETANI et al. (1985). The normal Upper Cretaceous to Eocene succession and the thick ductile Goma Shales are rather disturbed. This is not surprising when it is realized that the Goma Shales lie between the Shillakong- and Lingshet-Limestone formations and the overthrust Spongtang Klippe is just above.

The unreliability of constructing nappes from disturbed formation boundaries is demonstrated by the features of the Panjal Trap – a rigid formation below the softer Permo-Triassic series broken up into slabs (e.g. north of Karsha) and showing sheared boundaries. The basal "thrust" of the "Zangla Nappe" has been placed at the base of the Panjal Trap (BAUD et al. 1982a, b), at its top (BAUD et al. 1983) or even at the base of the Po Formation (GAETANI et al. 1985, 1986).

The last shifting of the "nappe boundary" obviously was necessary after the discovery of the undisturbed nature of the stratigraphic contacts at the base of the Panjal Trap in the Tanze area (GAETANI et al. 1988; compare with FUCHS 1987, p. 474). I should like to emphasize that in this area we find the normal Palaeo-Mesozoic sequence with a few local imbrications (FUCHS 1987). The thrusting of Phe Formation over the Karsha Formation south of Tanze described by BAUD et al. (1984, Fig. 8) appears to be a simple fold. In a syncline the Kurgiakh Formation (CASNEDI et al. 1985) follows in stratigraphic order on top of the Karsha Formation. If this is the case the Kurgiakh Formation of the type area must have been mistaken for the older Phe Formation.

As a further proof of the SW-directed movements in the "Phuktal Unit" BAUD et al. (1984, Fig. 7) refer to the geometry of folds in the Yunnan Valley, north of Bara Lacha La. Actually this recumbent syncline closes to the south and thus is north vergent, as can be observed at the Kenlung camping ground.

Finally I take it as evidence against a major tectonic separation of the Panjal Trap from the underlying formations that the latter are penetrated by numerous basic dikes. GAETANI et al. (1986, p. 454–455) also refer to petrographical data suggesting correlation of these dikes with the Panjal Traps. From the observation that the dikes become especially abundant close to the overlying Panjal Trap (e.g. north of Phuktal) I conclude that the underlying formations represent the original substratum of the volcanic flows penetrated by their feeders.

4. The Southern Margin of the Tibetan Zone

Baud et al. (1982a, b, 1984) take the Tibetan sediment sequence as allochthonous and tectonically overlying the High Himalayan Crystallines. In their 1983 paper they give the interpretation that the HHC and the Palaeozoic formations up to the Panjal Trap formed one structural unit. Gaetani et al. (1985, 1986) favour a structural separation of the sediments from the Crystalline.

In the Padam area there is a marked break in metamorphic grade between the migmatites of the Central Crystalline and the metasediments of the Phe Formation. So I agree with Baud et al. (1982a, b) and Gaetani et al. (1985) that there must be a tectonic plane separating the metasediments and the high-grade metamorphic series (Fuchs 1987). Obviously Baud (1988) refers to this shear zone when he cites Herren (1987) and Searle & Cooper (1988) as providing evidence for the tectonic nature of the contact, without appearing to realize that they envisage a completely different mechanism.

These authors propose a downthrow of the sediments along a normal north-east dipping fault – a view confirmed by myself (1987, p. 483). This view is opposed to the assumption of a nappe thrust onto the Crystalline from the north.

Upstream the Tsarap the above named shear zone becomes insignificant and between the villages Ichar and Purni we find a gradual decrease of metamorphism from amphibolite facies to anchi-metamorphism.

Therefore it is not possible to draw a distinct boundary between the sedimentary series and crystallines. Similar passages were found west of Rangdum and in the Suru-Kashmir area (Fuchs 1977b) and are documented by the careful investigations of Honegger (1983). There the Panjal Trap-Triassic sequence attains amphibolite facies and forms part of the crystalline complex. In many other places of the Himalaya it is impossible to find a clear demarcation between the Tibetan Zone sediments and the Central Crystalline: Kashmir, Chamba (Fuchs 1975) Spiti (Griesbach 1981; Hayden 1904), Kumaun (Heim & Gansser 1939), Nepal (Fuchs 1967, 1977a; Bordet et al. 1971, 1975; Pecher & Le Fort 1986 and Bhutan (Gansser 1983).

The front of metamorphism appears to have reached up to different levels of the stratigraphic sequence and large portions of the Crystalline consist of metasediments incorporated from the Tethyan Zone. It would be difficult to separate these metasediments from the Crystallines and regard them as a higher nappe.

Quite a different situation is found in Lahoul, where no Central Crystalline is exposed. The thick monotonous basal series of the Tibetan Zone are still connected there with sediments of the Chamba Synclinorium.

These sedimentary series are intruded by granitoids. Gaetani et al. (1985) regard the contact of the Jaspar Granite in the valley north-west of Darcha as tectonic. Apophyses of the granite in the sediments as well as interfingering and inclusion of the country rock leave no doubt about the magmatic contact. Finally I would like to emphasize that the observed passages from the Central Crystalline into the Tibetan Zone are difficult to explain by the advocates of the nappe hypothesis, because the frontal parts of a nappe cannot be connected with the underlying units. On the contrary it is easy to explain tectonic contacts as a later disturbance of the original gradational contacts.

5. Conclusions

For the assumption of nappes it is not sufficient to refer to the existence of shear zones and disturbed formation boundaries. It is the *disturbed order of stratigraphic formations* which makes one suspect thrust tectonics.

However in Zanskar the alleged pile of nappes consists of formations of Palaeozoic to Eocene age *in normal stratigraphic order.* Complications by shear zones, wedges etc. turn out to be of local importance only when followed along the strike.

To use the term "nappe" it is necessary to provide evidence of a major *horizontal transport.* This can be documented by *outliers* and *tectonic windows.* Up to now such elements of nappe tectonics are unknown from the Tibetan Zone of Zanskar. There is evidence for the allochthony of the Spongtang Outlier, which consists of units thrust from the Indus Suture Zone, but not for nappe tectonics *within* the Tibetan Zone. Thus it is uncritical to speak of nappes or thrust units without proving their horizontal displacement. Therefore recently introduced terms like "Phuktal Unit", "Zangla-Lingshet Nappes" etc. are to be abandonned.

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