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Pebble-slates in parts of eastern Himalaya –evidence for Pre-Gondwana deformation in Himalayan Rocks

S. SEN GUPTA AND S. S. RAY
Department of Geology, Presidency College, Calcutta 700073

Abstract

The pebble-slates in Sikkim and Bhutan are identical in character. They are conformably overlain by Gondwana rocks and have a gradational relationship with the underlying Buxa rocks in Sikkim. In Bhutan the main band overlies Buxa type lithology conformably but small conformable lenses of this rock are seen within the Buxas. It is suggested that they have been deposited over a span of time starting from the closing phases of Buxa deposition and continued till the base of the Gondwanas. Clasts of folded mica schist, folded carbon phyllite and veined dolomite indicate that they have been derived from a terrian exposing deformed and metamorphosed Buxa like lithology. Angularity of the clasts and presence of plenty of fresh feldspar fragments suggest very little transport of these sediments. The provenance belonged to the Himalayan domain and the deformation recorded in the clasts is pre-Gondwana tectonic element recorded in the provenance. This might be Hercynian or even pre-Hercynian.

Introduction

The pebble-slates form an important lithostratigraphic unit in eastern Himalaya. The report of the occurrence of fossils in these rocks exposed in Sikkim (Ghosh, 1956) made them all the more important as they occur associated with other unfossiliferous rocks whose stratigraphic position is not known. Subsequently similar rocks have been reported from Darjeeling foothills (Acharyya, 1971) and Bhutan (Nautiyal *et al.*, 1964). Fossils recorded from Sikkim indicate a Sakmarian age for these rocks (Ghosh, 1956). The lithological identity of pebble-slates exposed in different regions over the entire eastern Himalaya is so complete that all of them are believed to have been deposited during Sakmarian. As a result this particular rock type has been used as a stratigraphic marker and utilised for correlation in this area of dominantly unfossiliferous rock formations. Observations so far recorded indicate a gradational relationship between this unit and the underlying Buxas at places (Acharyya, 1971; Acharyya *et al.* 1975) and Daling-Buxa parentage for some of the clasts is also suggested (Acharyya, 1971; Sinha Roy, 1973).

Pebble-slates have been studied from within the Rangit window and in exposures of eastern Bhutan. The geographic distribution of this lithostratigraphic unit is shown in Fig. 1. Study of the clasts and field relations of this unit with Buxas have led the authors to arrive at conclusions varying from the presently accepted views

Geologic association and description of clasts

The samples from Sikkim have been collected from a pebble-slate band in Namchi-Maniram area. They are conformably overlain by gritty sandstone and shale, bearing Gondwana plant fossils. The immediately underlying rocks are phyllitic marble of Buxa Formation with a gradational contact between the two units.

In eastern Bhutan pebble-slates are exposed as one main band and also as small lensoid bodies, closely associated with an assemblage of dolomite, gritty quartzite and slates. The dolomites are stromatolite bearing in a number of places. There are some more exposures of pebble-slates in the northwestern parts of Bhutan. These exposures contain lower Permian fossils and are associated with a Paleo-

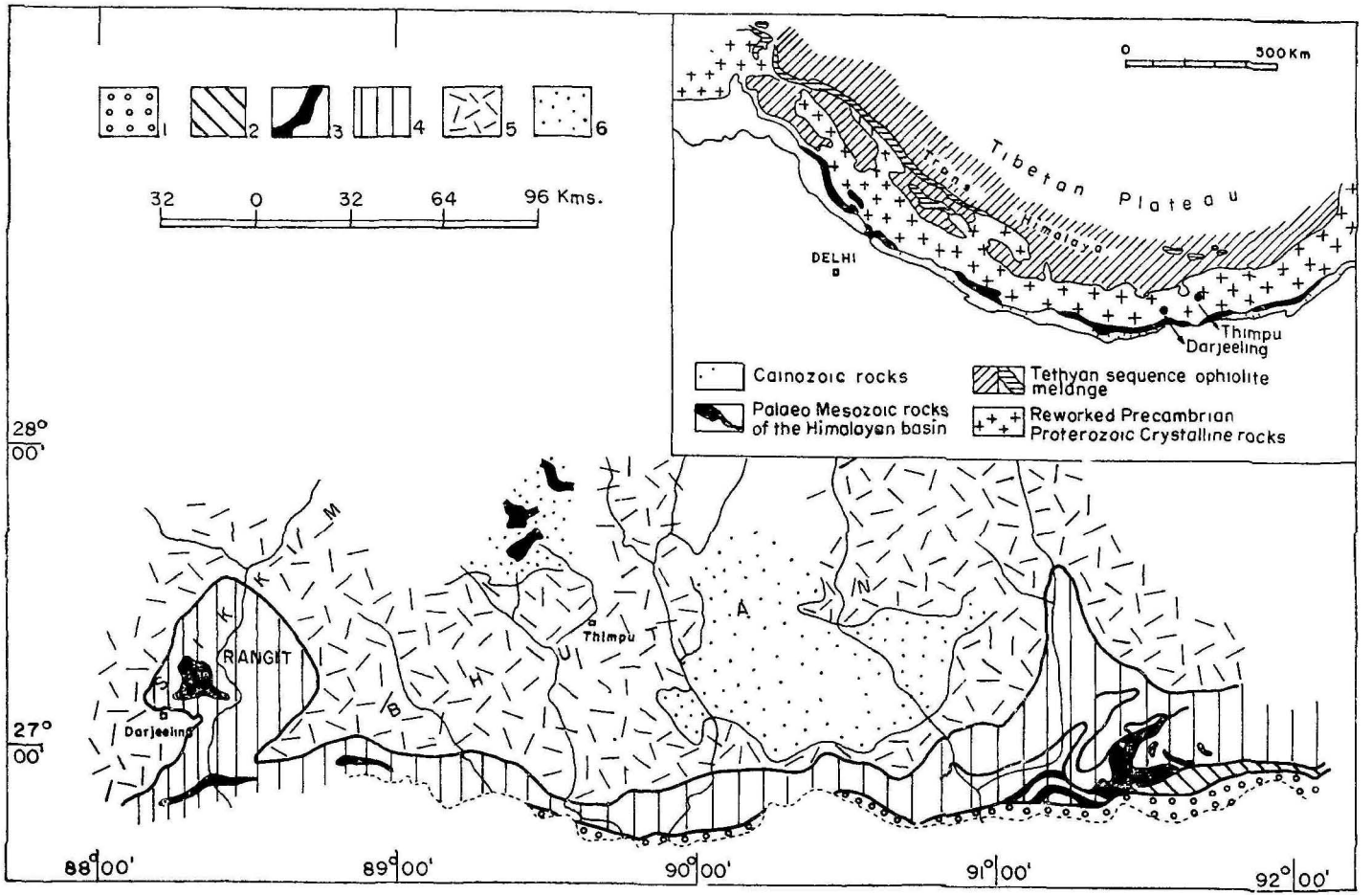
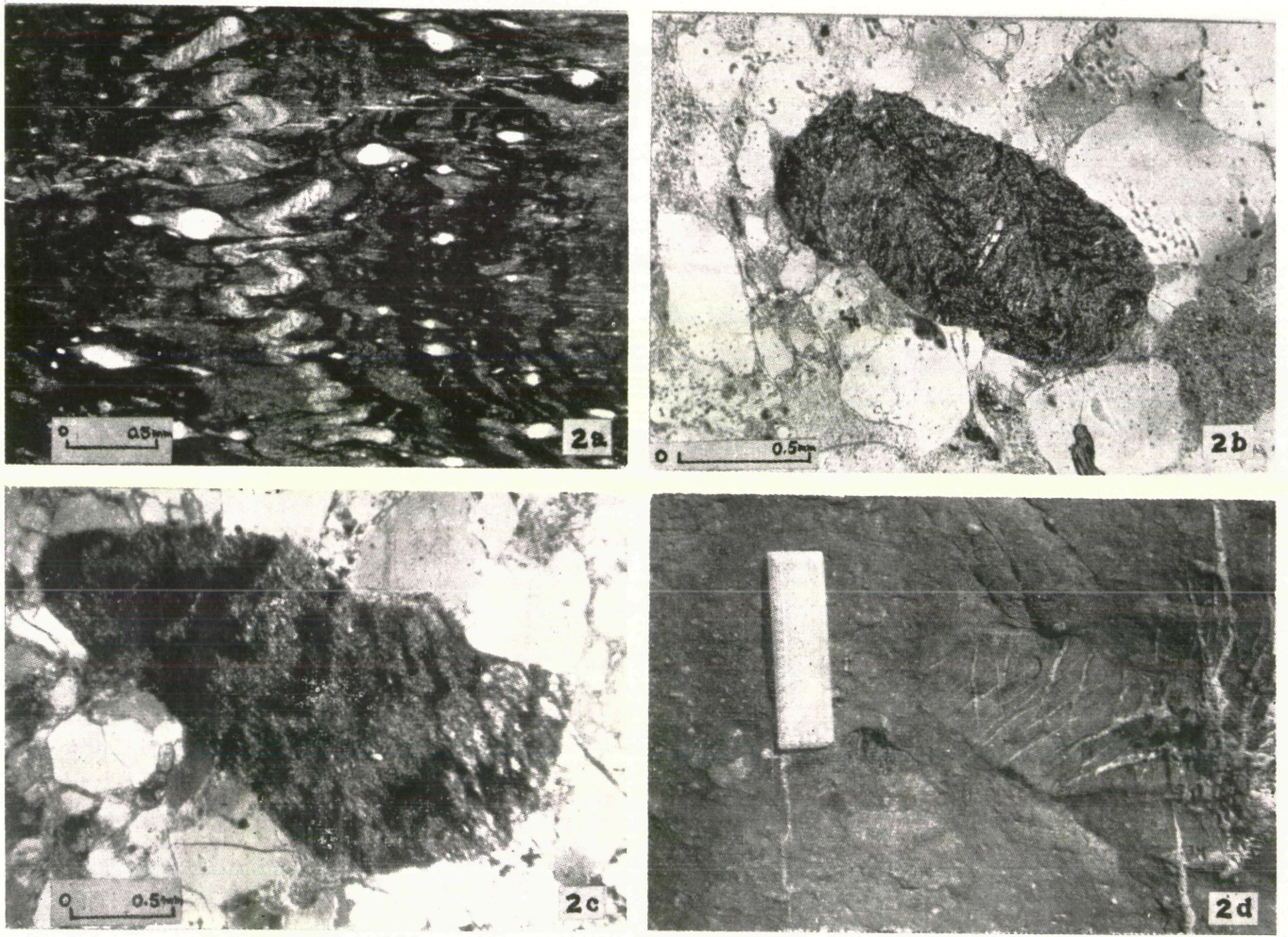


Figure 1. Map showing distribution of pebble-slates in Sikkim-Bhutan Himalaya.

Legend: 1. Siwaliks, 2. Gondwana sandstone and shale, 3. Pebble-slate, 4. Buxas, 5. Gneisses and migmatites, 6. Paleo-Mesozoic fossiliferous sediments.



Figures. 2a, 2b, 2c and 2d

mesozoic fossil bearing Tethyan sequence. These exposures are mentioned to complete the description of geographic distribution; they have not been included in the study.

The pebble-slates from both the areas are identical. They consist of angular to subrounded clasts with a wide range of size embedded in a very fine grained foliated matrix. The term diamictite (Flint, Sanders and Rodgers, 1960) appears to be most suitable for this unit. In a number of samples folds defined by colour laminations are preserved, with the foliation (slaty clevage) parallel to the axial plane of these folds (Fig. 2a). In the other associated rock types also slaty cleavage is consistently present as axial planar structure of tight to isoclinal folds. The geometry of the folds in these rocks is identical with those recorded in pebble-slate. In both the areas this is the earliest tectonic element recorded in the rocks. In Bhutan this is found to be the regional E-W planar structure (its morphology varies to that of a crenulation cleavage in a few places) and continues through Darjeeling frontal zone into Sikkim, with local variations in attitude due to later folding. This planar structure is the imprint of a post-Gondwana deformational episode.

The larger pebbles are almost invariably of quartzite and dolomite. The quartzite pebbles are of varying colour and texture. The smaller clasts are of different types which include microcline-granite, mica schist, carbon phyllite and microcrystalline volcanic rocks. Schistosity in the mica schist clasts is defined by very fine grained quartz and muscovite. In a few clasts this planar structure is found to be folded (Fig. 2b). No high grade metamorphic mineral is found in any clasts of schistose rock. Some clasts of carbon phyllite show preserved fold structures defined by colour banding with a planar structure developed parallel to their axial plane (Fig. 2c). Large pebbles of veined dolomite are found (Fig. 2d). The quartz veins do not transgress the boundary of the pebbles and it is quite apparent that the pebbles have been produced from veined dolomite.

Conclusion

Pebble-slate in Rangit window conformably underlies Gondwanas and its infra-Gondwana status is proved beyond doubt. In eastern Bhutan, Gondwana rocks are nowhere found lying on top of pebble-slate and as a result their mutual relation cannot be established directly. Unfortunately no fossils are recorded from pebble-slates of eastern Bhutan. Assigning a basal Gondwana age for the rocks here, would therefore, be only an assumption based on observations made a long distance away. Before accepting this we have tried to establish the logic behind the acceptance. The situation observed in Eastern Bhutan is that the main band of pebble-slate is the youngest unit overlying conformably a sequence of gritty quartzite-dolomite-phyllite. This underlying sequence very well matches the description of Buxa lithostratigraphic unit (Acharyya, 1974). Other small conformable lenses of this rock are found in the top part of the Buxa-like sequence underlying the main band. Taking into consideration the observation of a gradational relationship between pebble-slate and Buxa in

EXPLANATION OF FIGURES

Figure 2a Folds in pebble-slate with axial plane slaty cleavage.

Figure 2b Clast of folded schistose rock.

Figure 2c Clast of folded carbon phyllite.

Figure 2d Pebble of veined dolomite.

Rangit window would mean existence of similar geologic conditions in eastern Bhutan. We conclude that deposition of diamictites in both the places ranged over a certain span of time, starting at the end of Buxa deposition. The small conformable lenses of diamictite in the top part of Buxa sequence represent the beginning. The main phase is probably synchronous all over and marks the begining of Gondwana deposition. Once the contemporaneity is established, the age decided for the rocks in a particular area can be extended to other areas where no direct fossil evidence is found.

The clasts in these diamictites have been derived from a terrain already metamorphosed and deformed, as is evident from fragments containing bedding folds and folded schistosity. Probably the grade of metamorphism of the rocks was low. From the composition of the clasts it is interpreted that the provenance exposed an association very similar to Buxa lithology except clasts of granitic material. The angularity of fragments, very poor sorting of the material and abundance of feldspar clasts suggest that the sediments were not transported over a long distance. The provenance was very close to areas of deposition and it continued from dolomite-carbon phyllite-quartzite of Buxa, through pebble-slate to Gondwanas. This nearby provenance exposed Buxa-like lithology which had already suffered deformation and metamorphism. This suggests that sedimentation of Buxa-like rocks occurred prior to deposition of the lithological association conventionally mapped as Buxas. This was separated by deformation and metamorphism from the latter 'Buxa' sedimentation.

The indication that the provenance was very near the depositional area leads to the suggestion that this already deformed and metamorphosed provenance might belong to the Himalayan domain. The schistosity seen in pebble-slate (Fig. 2a) and associated rocks is post Gondwana. In contrast the schistosity in the clasts should represent an earlier tectonic element. Therefore, the evolutionary history of the Himalaya will at least include this deformational event which is pre-Gondwana in age. Suggestion of the Himalaya having imprints of Hercynian orogeny have been made earlier (Sinha Roy, 1974). From the evidences discussed here it cannot be ascertained whether the pre-Gondwana deformation is Hercynian or even earlier.

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