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Differentiation of the significant Late Valanginian (Early Cretaceous) transgressive event in the Spiti Himalaya, India

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ABSTRACT

Nearly continuous sedimentary succession of Early Cretaceous age has been long known in the Tethyan Himalayan belt without differentiation of the individual stages. We discuss here our just realised differentiation of a relatively thin well bedded sandstone interval with significant presence of the characteristic Late Valanginian–Early Hauterivian ammonoid genus *Olcostephanus*. It lies within a dominantly sandy succession with shale interbeds of Giumal Sandstone Formation, near Gate in Spiti Himalaya. This is the first stratigraphically precise record of *Olcostephanus* from the Cretaceous of India. It is here circumstantially age constrained to the Standard Tethyan Verrucosum Subzone *Olcostephanus* expansion event to the High Himalayan belt.

1. Introduction

The Cretaceous is geologically one of the most eventful time interval of the entire Phanerozoic, particularly, in context of the Indian subcontinent. Marine Early Cretaceous outcrops are exposed almost all around the Indian subcontinent in western India (Kachchh, Jaisalmer and Pakistan), in the Tethyan Himalayan belt in the form of Giumal Sandstone Formation over a considerable length (Fig. 1) and on Indian East coast (Athgarh, Krishna–Godavari and Cauvery basins) (Krishna, 1983). Among these the Giumal Sandstone Formation has failed to receive adequate notice of biostratigraphers and allied geoscientists for long. On the other hand Early Cretaceous time interval has been well differentiated into 38 ammonoid zones and 43 subzones in the Standard Tethyan Scheme (Reboulet et al., 2009) developed in Europe. In comparison, our understanding about Early Cretaceous sedimentary succession in India, particularly in the Himalaya, is very poor. It has not been even possible to precisely differentiate the six Early Cretaceous stages.

Uhlig (1903–1910) described and illustrated the Early Cretaceous ammonoids (Berriasian–Valanginian) from the Himalaya in his detailed monographic work but without precise stratigraphic details. The data presented by Uhlig (1903–1910) cannot be utilised for biostratigraphic refinement. Gansser (1964) and Fuchs (1967) have made only passing references. Krishna et al. (1982) and Krishna (1983) initiated the study of the Himalayan Mesozoic succession and provided some meaningful contributions. In recent years (Krishna and Pathak, 1993, Pathak and Krishna, 1993, Pathak et al., 1995; Pathak, 1993, 1997, 2007) have in some measure contributed towards biostratigraphic refinement of Late Jurassic – Early Cretaceous sedimentary succession (Spiti Shale Formation and Giumal Sandstone Formation).

The present contribution includes description of the significant find of the Late Valanginian – Early Hauterivian index ammonoid genus *Olcostephanus* Neumayr (Rawson, 1999) with proper stratigraphic details, identification, dating, intrabasinal and possible intercontinental correlation as a significant Late Valanginian eustatically influenced transgressive event.

2. Area and material studied

The Spiti region receives much attention for its well developed thick Mesozoic succession along with moderately to well preserved invertebrate fauna, especially the chronostratigraphically significant ammonoids. It is a small isolated area (65 km long and less than half as wide) situated in the northern sector of the Indian plate in the state of Himachal Pradesh. The Early Cretaceous Giumal Sandstone Formation is exposed in its type area near Giumal conformably over the famous Spiti Shale Formation.

In the present investigated areas (Gate, Kibber and Chichim, Fig. 2), the early part of the Early Cretaceous Giumal Sandstone Formation has its best development north of the village Gate which is in-turn about 20 km north of Kaza, the sub-divisional headquarter of Lahaul–Spiti district of Himachal Pradesh, India.

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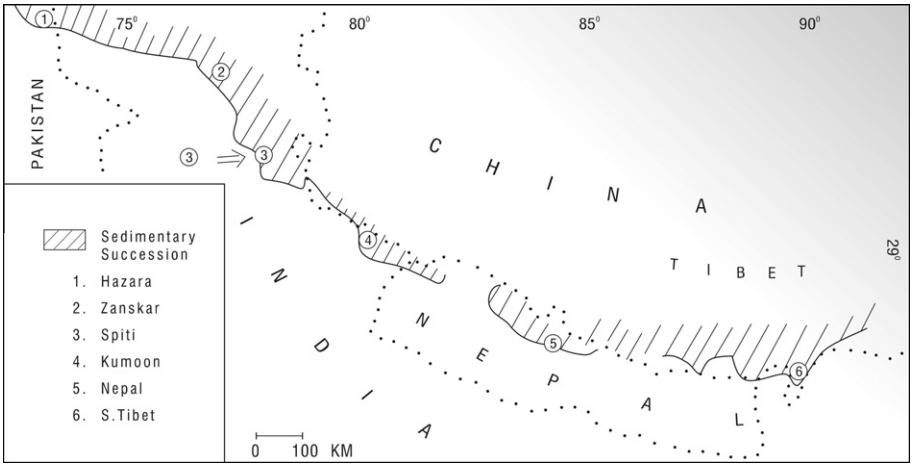

Fig. 1. Important localities of the Tethyan sedimentary succession in Himalaya.

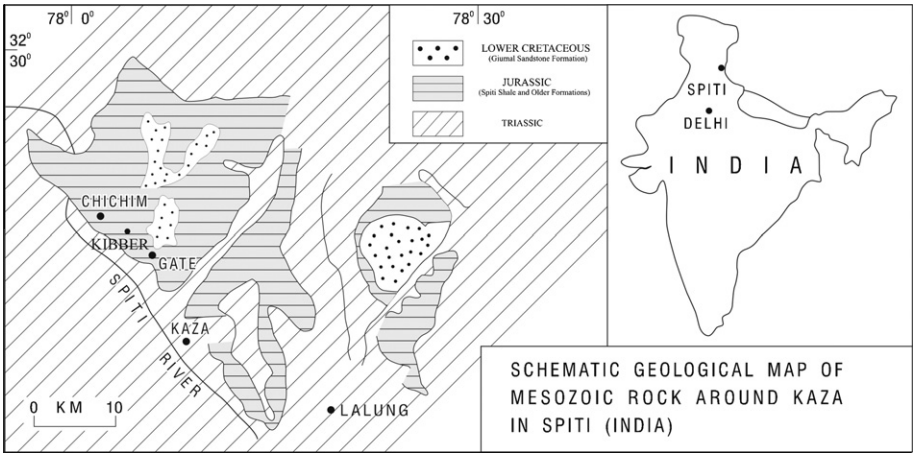

Fig. 2. Schematic geological map of Mesozoic rock succession in the studied area.

In general Giumal Sandstone Formation is relatively poorly fossiliferous in comparison to underlying Spiti Shale Formation. The entire succession is sandstone dominating. The basal 10–15 m part of succession is relatively more fossiliferous with ammonoids in thin shale/silt intercalations. Thereafter, there is drastic reduction in ammonoid density. The occasionally enclosed impressions are extremely difficult to extract from the outcrops. In comparison to collection of several ammonoid specimens from the basal 10–15 m part, mere 5 specimens of ammonoids were recovered out of several impressions from a level ca 80 m above the base of the Giumal Sandstone Formation (bed 19, Fig. 3). These are here determined as *Olcostephanus* (*O.*) aff. *atherstoni* (Sharpe).

3. Lithostratigraphic remarks

The Giumal Sandstone Formation is underlain by ca 150–250 m thick Spiti Shale Formation. The highly fossiliferous, lithologically distinctive, grey to dark black shales include frequent ammonoid bearing concretions. However, the presence of belemnites, bivalves, gastropods etc. in this unit cannot be overlooked. The age of Spiti Shale Formation ranges from Oxfordian to Tithonian (Pathak and Krishna, 1993; Pathak, 1997).

The Giumal Sandstone Formation appears abruptly as predominantly pinkish white to pale yellow and light brownish grey quartzitic sandstone with shale interbeds. There are coarsening upward regressive cycles of several (few cm to 15 m thick) sandstones separated by relatively thinner, brownish grey silty shale and siltstone beds (Fig. 3) with distinct increase upward in the thickness of sandstone beds coupled with sharp decrease in shale/siltstone intercalations.

The studied ca 200 m thick Giumal Sandstone Formation has been differentiated into 32 distinct beds and 4 distinct ammonoid levels. Most of the sandstone beds are capped by a few cm thick ferruginous sandstone bands rich in diverse fossil groups. *Olcostephanus* specimens have been recovered from ca 5 m thick sandstone bed 19, about 80 m above the base of Giumal Sandstone Formation.

4. Palaeontologic remarks

Spiticeras, *Neocosmoceras*, *Odontodiscoceras*, *Berriasella* and *Kilianella* have been determined from beds 1 to 5 and *Olcostephanus* from bed 19 (Fig. 3). Out of the above genera, *Olcostephanus* fragments mark their first stratigraphically precise record from anywhere in India. The earlier records by Uhlig (1903–10) lacked stratigraphic details which Uhlig erroneously grouped with definite Berriasian forms from upper part of Spiti Shale Formation.