Depositional and Diagenetic History of the Lower Siwalik Subgroup (Miocene), Northwest Himalaya, Jammu (India)*

Sundeep K. Pandita¹ and Sunil K. Bhat²

Search and Discovery Article #50532 (2012)
Posted January 17, 2012

*Adapted from poster presentation at AAPG International Convention and Exhibition, Milan, Italy, October 23-26, 2011

¹Department of Geology, University of Jammu, Jammu, India (sundeep.pandita@gmail.co)
²Department of Geology, University of Jammu, Jammu, India

Abstract

In the Northwestern part of the Himalayan Foreland Basin, the Jammu region exhibits 6 km thick sedimentary succession of Siwalik Group exposed on the northern and southern limbs of the thrust cored Suruin-Mastgarh anticline and forms a link between the Siwalik rocks exposed in Pakistan in the west and beyond the Ravi River (India) in the east. These rocks are disposed in parallel folded zones and generally dip towards the southwest or the northeast at varying angles between 80 (Lower Siwalik) to 10 (Upper Siwalik) degrees.

The Ramnagar area of the Udhampur District in Jammu and Kashmir State exposes a thick pile of the Lower Siwalik rocks sandwiched between the Murree Group and the Middle Siwalik Subgroup on both the limbs of the doubly plunging Udhampur Syncline. Detailed sedimentological study has been carried out on two stratigraphic sections (Kalaunta and Ramnagar) in this area to establish the depositional and diagenetic history. Here the rocks consist of brown, reddish brown, grey and buff sandstones, reddish brown to dark brown siltstones, and light brown to reddish brown mudstones.

The stratigraphic accumulation of facies associations and evolution of fluvial style during the deposition of these rocks has developed in two stages. The stage first started with deposition of predominance of fine grained facies (mudstone and siltstone) as facies association FA1 in the Kalaunta section followed by dominance of flood flow and crevasse splay sediments characterized by lateral accreted cross stratified sandstone deposits of facies association FA2 in the Ramnagar section. Facies association FA3 comprises a sequence of fine to very fine sandstones, siltstones, and mudstones overlying the sand-mud dominated association and was deposited during these two stages as interfluvial deposition. These rocks are interpreted to have been deposited by a changing river system from fine grained meandering in the lower Kalaunta section to flood flow dominated meandering system in the upper Ramnagar section.
Diagenetic signatures observed in the sandstones of the area show a reduction in porosity from 42 to 15%. The major cause of the reduction in the porosity was due to cementation in the Kalaunta section and compaction in the Ramnagar section. Porosity versus depth relationship plots suggests a depth of burial in the range of 933 to 2000 m for the Kalaunta section and 800 to 1500 m for the Ramnagar section.

References


In the Northwestern part of the Himalayan Foreland Basin, the Jammu region exhibits 6km thick sedimentary succession of Siwalik Group exposed on the northern and southern limbs of the thrust cored Surain-Mastgar anticline and forms a link between the Siwalik rocks exposed in Pakistan to the west and beyond the Ravi River (India) to the east. These rocks are disposed in parallel folded zones and generally dip towards the southwest or the northeast at varying angles between 80 (Lower Siwalik) to 10 (Upper Siwalik) to the web. The Ramgarh area of the Udhampur District in Jammu and Kashmir State exposes a thick pile of the Lower Siwalik rocks sandwiched between the Murrue Group and the Middle Siwalik Subgroup on both the limbs of the doubly plunging Udhampur Syncline. Detailed sedimentary studies have been carried out on two stratigraphic sections (Kalauna and Ramnagar) in this area to establish the depositional and diagenetic history. Here the rocks consist of brown, reddish brown, grey and buff sandstones, reddish brown to dark brown siltstones and light brown to reddish brown mudstones.

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Diagenetic signatures observed in the sandstones of the area show a reduction in porosity from 42 to 15%. The major cause of the reduction in the porosity was due to cementation in the Kalauna section and compaction in the Ramnagar section. Porosity versus depth relationship plots suggest a depth of burial in the range of 933 to 2000m for the Kalauna section and 800 to 1500m for the Ramnagar section. The Ramgarh area of the Udhampur District in Jammu and Kashmir State exposes a thick pile of the Lower Siwalik rocks classified as Ramgarh Formation by Gupta and Shaili (1989) and is famous for its vertebrate fossil record. These rocks have been divided into Dodenal (=Kamlim Formation) and Ramgarh (=Chinji Formation) Members by Gupta (2000). Since the Ramgarh area has thick vegetation cover and the rocks are exposed along the streams, two representative lithostratigraphic sections of the Dodenal and Ramgarh Members, one in Kalauna (194m) and other at Ramgarh (310m) were properly measured and documented.

In Jammu region the Siwalik Group of rocks is exposed on the northern and southern limbs of the thrust cored Surain-Mastgar anticline extending from west to east as a connecting link between the Siwalik rocks exposed in Pakistan and beyond Ravi River (India). The Siwalik Group represents a thick sequence of about 6000m composed of sandstones, mudstones, and conglomerates, classified as Lower, Middle, and Upper Siwalik Subgroups and is disposed in parallel folded zones. These rocks generally dip in southwest-northeast direction at varying angles between 80° (Lower Siwalik) to 10° (Upper Siwalik).


<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Formation</th>
<th>Member</th>
<th>Lithology</th>
<th>Probable equivalents</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOWER SIWALK</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Boulder</td>
<td>Conglomerate to interlayered intervals of fine sandstone and rare mudstones, characterized by orange pigment in the matrix</td>
<td>Boulder</td>
<td>Early Pleistocene</td>
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<tr>
<td></td>
<td></td>
<td>Conglomerate</td>
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<tr>
<td></td>
<td></td>
<td>(boulder)</td>
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<td></td>
<td></td>
<td>Negrot (Uttarhuraisi)</td>
<td>Sandstone and conglomerate with interbeds of mudstones, laterally grading in to conglomerates</td>
<td>Pinjar</td>
<td>Early Pleistocene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parmandal (boulder)</td>
<td>Mudstone and sandstone alternations with minor conglomerate beds, laterally changing to grey conglomerate, containing lenticular bands of sandstone</td>
<td>Tararat</td>
<td>Late Pleistocene</td>
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<tr>
<td>MIDDLE SIWALK</td>
<td></td>
<td>Mohenj (boulder)</td>
<td>Predominantly multilithified sandstone pavings</td>
<td>Dhoopathan</td>
<td>Middle Pleistocene</td>
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<td>Desal</td>
<td>Massive, thickly bedded multistorel sandstone with subordinate mudstones</td>
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<td>Early Pleistocene</td>
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<tr>
<td>LOWER SIWALK</td>
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<td>Massar</td>
<td>Mudstone and sandstone fine to coarse sandstone alternations</td>
<td>Chirri</td>
<td>Late Pleistocene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dodenal</td>
<td>Very fine to medium sandstone, siltstone and mudstone</td>
<td>Kamliar</td>
<td>Middle Pleistocene</td>
</tr>
</tbody>
</table>

Fig.: Schematic cross-section through the Himalayas to show terrigenous evolution during Siwalik deposition (Modified after Singh et al., 2006). STD, South Tibetan Detachment; PT: Panjal Thrust; MBT, Main Boundary Thrust; DT, Digrail Thrust

Fig.: Relationship between minus cement porosity (MCP) and depth of burial on three bivariate diagrams (a, b, c) determined in the study area.