Volume : 2 | Issue : 5 | May 2013 • ISSN No 2277 - 8160

Research Paper Geology

A Sedimentological Study of the Sandstones of the Subsurface Barail Group from a part of Upper Assam Basin

J.N. Sarma	K.D. Malaviya Chair Professor, Department of Applied Geology, Dibrugarh University, Dibrugarh, Assam. PIN- 786004
Mondip Sarma	Research Assistant, K.D. Malaviya Chair, Department of Applied Geology, Dibrugarh University, Dibrugarh, Assam. PIN- 786004.
Ananya Chutia	Research Assistant, K.D. Malaviya Chair, Department of Applied Geology, Dibrugarh University, Dibrugarh, Assam. PIN- 786004.

ABSTRACT

The upper Assam basin is situated in the north-eastern part of India and is a NE-SW trending intermontane platform basin of Tertiary sedimentation. A sedimentological study of the sandstone of the Barail Group of Oligocene period, using subsurface samples from two oil wells of Upper Assam basin has been carried out. The study reveals that the percentages of different constituents of the sandstone are quartz- 45.25 to 57.22, feldspar- 1.4 to 7.95, lithic fragments- 4.3 to 11.67, mica- 1.5 to 7.4, cement- 10.07 to 20.32 and matrix- 10.8 to 22.57%. Grains of quartz and feldspar are sub-angular to sub-rounded. Both plagioclase and K-feldspar are found. Presence of chert indicates textural immaturity of the sandstones. The metamorphic rock fragments are dominant over the igneous and sedimentary varieties. Most of the sandstones are classified as lithic greywacke and sublith arenite. QFL triangular plot shows that the sandstone are of recycled orogenic source. The Q_mFL_t triangular plot shows that the sandstones under the study are of quartose recycled origin. Following the diamond diagram of Basu et al., (1975) it is found that the sediments are derived from middle, upper and low rank metamorphic sources. The diagenetic effect is shown by bending of detrital mica flakes and facturing of quartz grains.

KEYWORDS: Barail, sandstone, lithic greywacke, recycled orogenic, quartose recycled

Introduction

The Upper Assam basin is the earliest explored petroliferous basin of India. It is bounded on the north by the Eastern Himalayas, on the east by the Mishmi Massif, on the south by the Naga-Patkai Hills and on the west by the Mikir Hills and Shillong Plateau (Figure 1). The sandstones under study are drill core samples of sandstones of Barail Group of Oligocene age belonging to two wells, NHK#422 and KJN#11 of Naharkatiya and Kushijan of Upper Assam basin. The samples from the NHK#422 well are from the depth range 3047 to 3055 m and those from the KJN#11 are from 3989 to 4005 m.

The Upper Assam basin has been producing oil and gas for more than a century, mainly from araneceous part of Barail Group (Oligocene) and Tipam Sandstone Formation (Miocene) reservoirs. The Arenaceous Unit of Barail Group contains significant quantities of oil reserve and is quite extensive in Assam geological province. It stratigraphically overlies the Jaintia Group of rocks of Eocene age and underlies unconformably the Surma Group. The sandstones of Barail Group occur in the subsurface of Upper Assam plains and are exposed in different localities such as Dilli river, Dirak river, Namdang river river, Tipong Pani, and Namchik river etc of Upper Assam. Various published works have described that the Barail Group of rocks were deposited in deltaic environment. The present study deals with the petrography of the sandstones of Barail Group from the two wells mentioned earlier.

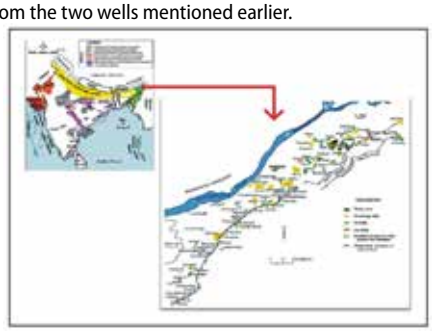

Figure 1: Location map of the area under study

Geology of the Area

The Upper Assam Valley is situated between the Eastern Himalayas and the Naga Hill Ranges. In most of the places thick succession of the Palaeogene deposits of the shelf area directly lie over the granitic gneiss. The shelf facies sediments grade into geosynclinal facies sediments, with the dividing line between the two facies occurring in the vicinity of the Naga Thrust, which is the north-western margin of the Belt of Schuppen. The Tertiary succession of Upper Assam shelf sediments, after Handique *et al.* (1989), is given in a tabular form in Table 1.

Table 1: Tertiary succession of Upper Assam shelf sediments, after Handique et al. (1989)

Epoch	Litostratigraphic Group	Units/Formation	Thickness (in m)	Major Lithological Types
Recent Pleistocene	Dihing	Alluvium[1] Dhekiajuli[1]	1300-2000	Unconsolidated sands with clay and lignite sands.
		Unconformity		
Pliocene Miocene	Dupitila	Namsang Beds	0-1000	Poorly consolidated sandstone with clay and lignite sand.
		Unconformity		
Miocene	Tipam	Girujan Clay	100-2300	Mottled clay with sandstone lenses.
		Tipam (Upper Sandstone (Middle (Lower	300-500 100-200 100-200	Essentially arenaceous Sequence. Sand/Shale alteration Sequence. Arenaceous sequence.
	?Surmas[2]	Not subdivided		Sandstone with shale and grit bed.
		Unconformity		
Oligocene	Barail	Not subdivided	500-1200	(Upper Part: Mudstone/ shale with sandstone beds and coal bands (Argillaceous sequence). (Lower Part: Sandstone with shale bands (Arenaceous sequence).
Eocene[3]	Jaintia	Kopili alternations	280-500	Splintery shales with sandstone and fine-grained sandstone with coal bands.
		Sylhet Limestone (Prang (Narpuh (Lakadong	350-450 60-170	Splintary shales with sandstone and limestone bands.
	Therria			Sandstone, calcareous sandstone and limestone.
		Unconformity		
Precambrian Granitic Basement				

Note:
1. It is difficult to distinguish these two rock units. From regional geologic considerations, an unconformity could however, be inferred between them.
2. Development of the Surma Group which is extensive in the type area of Surma Valley is doubtful in the Upper Assam shelf area.
3. Including Paleocene rocks

Results

Petrographic study of the sandstones of Barail Group has shown that the minerals constituting them are as follows:

Quartz: It is the dominant detrital constituent. The grains are subrounded as well as subangular to angular. Both elongate and equidimensional grains are present. Percentage of monocrystalline undulose quartz varies from 20 to 25.95% and that of non-undulose quartz varies from 11 to 15.68%. Polycrystalline quartz with '>3 crystal units per grain type' (6.86 to 11.2%) is dominant over '2-3 crystal unit per grain type' (1.45 to 4.32%). Of the polycrystalline quartz with '>3 crystal units per grain type', different types such as stretched metamorphic quartz, schistose quartz, and recrystallized metamorphic quartz are present. The boundaries of some of the grains have been corroded by ferruginous cement. A number of chert grains have been observed; most of these are of diagenetic origin.

Feldspar: The grains are subrounded as well as subangular. Both plagioclase and K-feldspar are present. The total percentage of feldspar varies from 2.47 to 7.95%. A number of weathered feldspar grains have been observed.

Mica: Muscovite and biotite of both detrital and diagenetic origin are present. The total percentage of mica varies from 0 to 3%. Both elongate and tabular flakes are present. Alteration of argillaceous cement to muscovite has also been noticed.

Lithic Fragments: All types of lithic fragments, i.e. metamorphic, igneous and sedimentary, are present. The total percentage varies from 5.23 to 10.95%. Metamorphic variety dominates over the other two types.

Cement: The types of cement present are argillaceous, ferruginous and siliceous. Total percentage of cement ranges from 10.07 to 20.32%. Argillaceous type dominates over the others and in some places it shows alteration to mica. Coating of ferruginous cement over argillaceous cement has also been observed, which indicates early formation of the latter. Siliceous cement occurs in the form of quartz overgrowth.

Matrix: Both argillaceous and siliceous matrix has been observed, of which argillaceous type is dominant over the siliceous type. The total percentage varies from 13.2 to 23.1%.

Results of the modal analysis of the sandstones of Barail Group are given in Table 2. A number of photomicrographs representing the mineral constituents of these sandstones are presented in

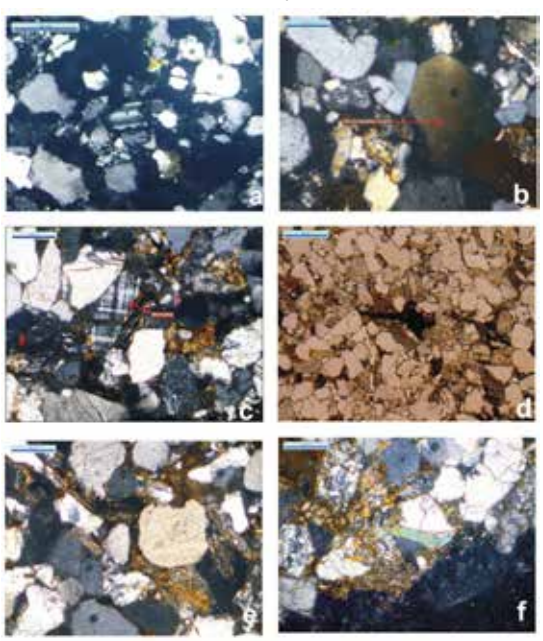

Figure 2 : Representative photomicrographs of the studied sandstones – (a) Association of quartz, feldspar and lithic fragments, (b) Monocrystalline undulatory quartz showing wavy extinction (c) Fractured microcline showing cross hatch twinning (d) Argillaceous cement occupying intergranular space (e) Development of authigenic mica in the intergranular space (f) Bending of a mica flake .

Discussion and Conclusions

The sandstones of the Barail Group are mainly of lithic greywacke and sublith arenite types of Dott, 1964 (in Pettijohn, 1984). Development of authigenic mica at the expense of argillaceous matrix is frequently observed in the sandstone. Such development of authigenic mica indicates that the sandstone have undergone diagenetic changes. The mechanical compaction of sediments is witnessed by bending of detrital mica flakes. Presence of chert in all the samples indicates textural immaturity of the sandstones, which is also supported by angularity of the grains and their poor sorting. In some of the samples occurrence of ferruginous cement coating on argillaceous cement indicates early formation of the latter. Presence of ferruginous cement indicates eodiagenetic stage of diagenesis. This also infers presence of non-marine environment where oxidizing condition commonly prevail leading to production of iron oxides.

Diamond diagram indicates that the constituents of most of the sandstones under study were derived from middle and upper rank metamorphic rocks and low rank metamorphic rock. QFL triangular plot of Dickinson *et al.* (1983) indicates that the sandstones are derived from recycled orogenic sources. Q_mFL_t triangular plot of Dickinson *et al.* (1983) shows that the sandstones were mainly of quartzose recycled origin.

Acknowledgement: The authors are grateful to Oil India Limited, Duliajan, for extending financial assistance to carry out the study under the OIL endowed K. D. Malaviya Chair, Department of Applied Geology, Dibrugarh University, Assam.

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