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Research Paper

Tectono-Provenance and Reservoir Rock Characteristics of the Tipam Sandstones in Parts of Upper Assam Basin

Geology

KEYWORDS : Tectonic setting, Reservoir characteristics, Tipam Sandstone, Upper Assam

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ABSTRACT

The Tipam Sandstone Formation belongs to Late Miocene to Early Pliocene age and it is one of the main oil producing horizon of Upper Assam Basin. It varies widely in thickness from area to area owing to a major unconformity at the top. The sandstones are composed mainly of quartz, rock-fragments, and mica. The contribution of quartz varies from 43.5% – 57.5%. Both the monocrystalline and polycrystalline quartz are reported. Feldspars varies from 2.2% - 2.5%, rock-fragments varies from 7.0% - 7.5%. The sandstones have undergone all the stages of diagenesis. Dissolution features, quartz overgrowth, transformation of secondary minerals are frequently reported. These diagenetic changes have a direct control on the reservoir quality of the sandstones. The sandstones are mainly subarkosic and wacke type. The sandstones are derived from varied sources however middle rank of metamorphic origin is dominating. Volumetric analysis of major oxides suggests that the sandstones are derived from active continental margins and subordinately from the continental island arc provenance.

Introduction:

The Upper Assam basin has sustained interest in oil exploration and exploitation for more than a century. It is one of the oldest petroleum producing basins of the world. The basin is bounded by in the north by the eastern Himalayas, in the east by the Mishimi Massif, in the south by Naga-Patkai Hills and in the west by the Mikir Hills and Shillong Plateau. A thick pile of sediments ranging in age from Cretaceous to Pleistocene has been deposited in the basin. Commercial hydrocarbon production from Upper Palaeocene to Mio-pliocene has been established in this basin. In the subsurface, a ridge of Precambrian rocks known as Brahmaputra arch roughly bisects the Assam Basin and it is an important feature from the hydrocarbon entrapment point of view. The Tipam Sandstone Formation of Miocene age constitutes one of the main oil bearing horizon in the Upper Assam Basin and it contains a significant percentage of known hydrocarbon reserves of Assam Geological Province.

Objective of the study:

The main objective of the present study is to evaluate the reservoir characteristics of the Tipam sandstones with the help of petrography and scanning electron microscope study and to determine the tectonic setting of the source area.

Materials and Methods:

In the present study, conventional core samples have been collected with due permission from the management of Oil India Limited, Duliajan, Assam. Detail thin section petrography, scanning electron microscope study and geochemical analysis for major oxides were carried out to achieve the goal of the objectives of present study.

Results and Discussion:

Petrographic study reveals that quartz is the most dominant constituent of the Tipam sandstones. and they normally show floating texture (fig.1a). Grains are sub-angular to sub-rounded and varies from 43.5 - 60.5%. The irregular boundary indicates the pressure solution effect. Polycrystalline quartz grains are recorded as composite, schistose and pressure metaquartz (fig.1b). Certain monocrystaline quartz grains show inclusions of zircon, mica, hornblende, tourmaline etc. indicating its igneous origin. The plagioclase feldspar is dominating over the orthoclase and microcline. The average percentage of feldspar in the sandstone of the present study is about 2.2-5%. The grains are subangular, subrounded and prismatic and some of them are found to be fractured. In spite of fracturing, some feldspar grains show banding and displacement in thin lamellae which is due to the thrusting effect of Belt of Schuppen. Flakes of muscovite and biotite are found between quartz grains (fig.1a). They constitute 3-12% of the total constituents. Rock. Metamorphic rock fragments are generally dominating over the igneous and sedimentary origin (fig.1c). The average percentage of rock fragments in the sandstone is 7.5%. In the present investigation chert grains are very frequently observed and their percentage is about 8.2%. The matrix is argillaceous as well as siliceous in nature constituting about 12% in the studied samples. The argillaceous matrix is characterized by the presence of clay and recrystallised micas along with liberation of iron (fig.1d). All types of cements are recorded constituting 25%-35%. Grain boundaries are seen to be corroded by the precipitation of the ferruginous cement. Petrographic evidences shows that the argillaceous cement is the first generation cement followed by the calcareous and then the ferruginous cement. In certain cases calcite crystals showing good cleavage are found to generate from the cementing material (fig.1f) within the framework grains.

The sandstones are moderately to poorly sorted. The sandstones are mainly subarkosic and quartz wacke type (Fig.2). Following Dickinson et. al.(1983), it is seen that the sediments were derived from uplifted terrains of folded and faulted strata from which recycled detritus of sedimentary and metasedimentary origins are being contributed (Fig.3). From Diamond diagram plot (after Basu et. at. 1975), it is found that the samples are derived from middle and upper rank metamorphic to low rank metamorphic sources (Fig.4). An attempt is made to find out the tectonic setting of the provenance with the help of sandstone chemistry. In bivariant plots (fig.5) of (Fe_2O_3 + MgO) vs. TiO_2, (Fe_2O_3 + MgO) vs. Al_2O_3/ SiO_2, (Fe_2O_3 + MgO) vs. K_2O / Na_2O and (Fe_2O_3 + MgO) vs. Al_2O_3 / (CaO + Na_2O), it has been observed that the sandstones of present study are derived from active continental margin and subordinately from the continental island arc provenance. The active continental margin type of sandstones are characterized by low Fe_2O_3 + MgO, TiO_2 and . K_2O / Na_2O is nearly 1, which is well observed in the sandstones of present study. Higher percentage of SiO_2 also indicates its derivation from the passive margin

Under SEM certain quartz grains show intragranular fracturing as well as overgrowths. Various types of open pores are present within the rocks of the sandstones. However, these pores are usually partly or completely filled with authigenic clay minerals such as stacks of kaolinite (Fig.6a). The commonly recorded clay minerals are kaolinite and illite. Chlorite occurs in clusters in some areas only. Smectite is occasionally observed, but tends to occur mainly as mixed-layer clays such as smectite-illite (fig.6b). Formation of framboidal pyrite (fig.6c) crystals in the inter spaces of the framework grains occupy partly or wholly the pore spaces and thereby reduces the porosity and permeability. So, some of the diagenetic changes within the reservoir make certain horizons to be highly productive while others make to be less productive in spite having good reserves.

CONCLUSION

The study reveals that the Tipam Sandstones are derived from recycled orogenic provenance and are mainly the products of lower to middle rank metamorphic sources followed by sedimentary and igneous sources. Major element composition indicates their derivation mainly from active continental margin and subordinately from the continental island arc as well as passive margin.The diagenetic alterations control the reservoir quality of the sandstones of present study. The precipitations

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of cementing materials, authigenesis of secondary minerals like chert, mica, and quartz overgrowth are some of the important diagenetic changes responsible for porosity reduction. Mineral dissolution has resulted in an increase in porosities within the sandstones. Some of the diagenetic changes make certain horizons to be highly productive while others make it to be less productive in spite having good reserves. Such as, presence of kaolinites and fibrous nature of illite in the pore throats also play an important role in porosity reduction. Conversely development of intragrnular fractures, corrosion, dissolution and partial replacement of the framework grains by cementing materials contribute towards the development and enhancement of secondary porosity and permeability.

ACKNOWLEDGEMENT

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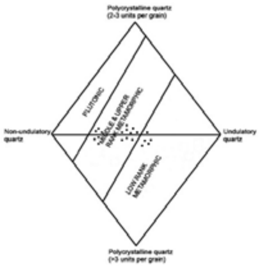
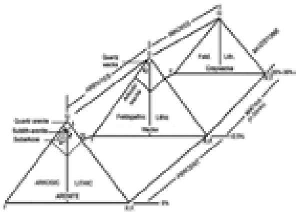



Figure 2 : Classification of Tipam Sandstones Figure 4: Diamond diagram (modified after Dott, 1964). (after Basu et.al. 1975)

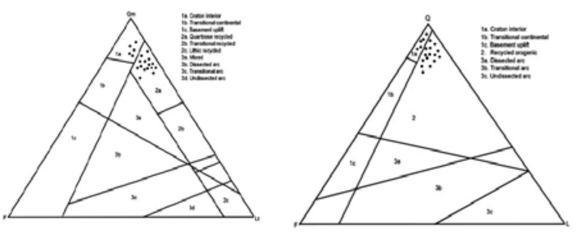
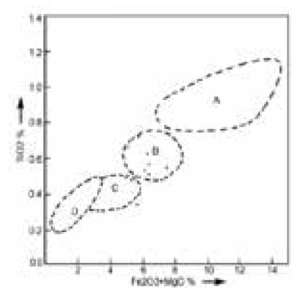
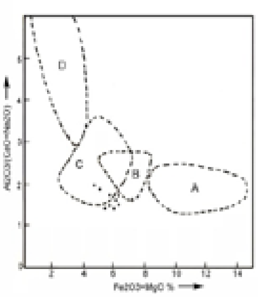
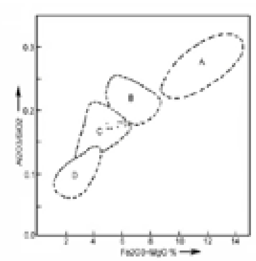
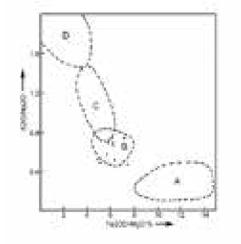


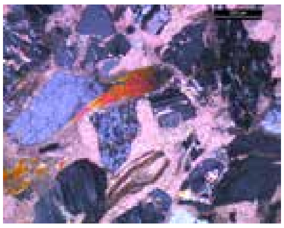
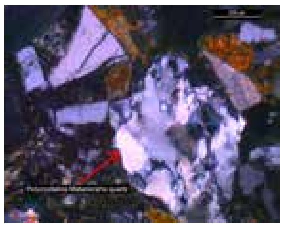
Figure 3: QFL & QmFLt plots for provenance discrimination of Tipam Sandstone of Upper

Assam Shelf (after Dickinson & Suczeck,1983)

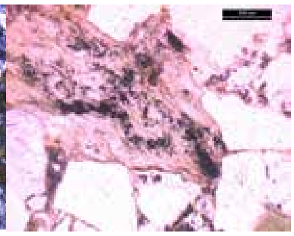





A-Oceanic, B-Continental Island Arc, C- Active continental margin, D- Passive margin

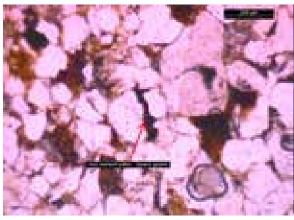
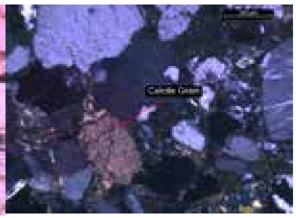
Figure5: Source area tectonic setting discrimination. (after Bhatia, 1983)

(a) **(b)**

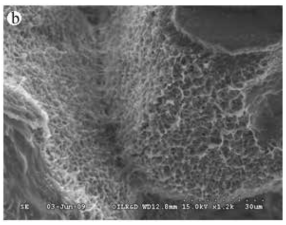
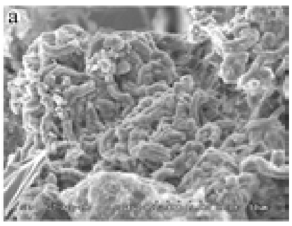
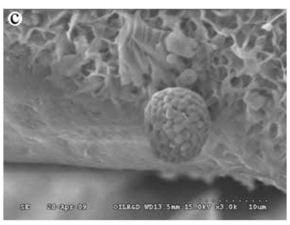
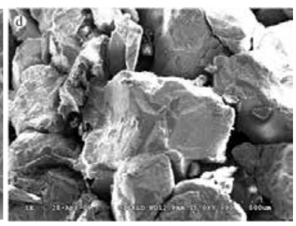


(c) **(d)**

(e) **(f)**

Figure 1: Photomicrographs showing (a) framework grains floating in calcite cement (b) polycrystalline quartz of metamorphic origin (C) silty rock fragment (d) recrystallisation of argillaceous cement into micaceous material liberating iron (d) ferruginous cement precipitating in intergranular spaces (d) Calcite grain. (Magnification 100x)

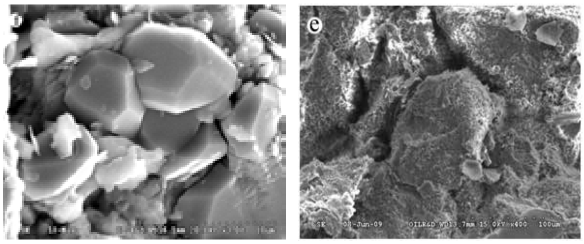


Figure 6: SEM Photomicrographs showing, (a) kaolinite verms, (b) illite-smectite layer, (c) framboidal pyrite, (d) inter particle pore spaces, (e) smectite coating over grain, (f) quartz overgrowth. (Magnification shown in the photomicrographs)

REFERENCE

Basu A. Young S. W., Suttner L. J., James W. C. and Mack G. H., 1975: Re-evaluation of the use of undulatory extinction and polycrystallinity in detrital quartz for provenance interpretation. Jour. Sed. Pet., 1975, v.45, pp.873-882. | Bhatia M.R., 1983: Plate tectonic and geochemical composition of sandstones. Jour. of Struc. Geol., v.91, pp.611-627. | Dapples E.C., 1967: Diagenesis of Sandstones. In Diagenesis in Sediments (ed. Larsen G. and Chillinger V. G.) , Elsevier Publishing Company, Amsterdam, pp.91-125. | Dickinson W. R., Beard I. S., Brakenridge G.R., Erjavec J. I., Ferguson R.C., Inman K. F., Knepp R. A., Lindberg F.A. and Ryberg P.T., 1983: Provenance of North American Phanerozoic Sandstones in relation to tectonic setting. Geol. Soc. Amer. Bull., v. 94, pp 222 – 235. | Dott R. H. Jr., 1964: Wacke, greywacke and matrix – what approach to immature sandstone classification? Jour. Sed. Pet., v.34, pp.625-632.

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